APPENDIX C: AN EVALUATION OF WESTERN WASHINGTON COASTAL MARINE AREAS AND ADJACENT LANDS: SPECIAL REPORT

Special Report

Information Pertinent to Site Selection for the Proposed Olympic Coast National Marine Sanctuary:

An Evaluation of Western Washington Coastal Marine Areas and Adjacent Lands

Strategic Assessment Branch
National Oceanic and Atmospheric Administration
Office of Oceanography and Marine Assessment
6001 Executive Blvd., N/OMA31
Rockville, MD 20852
(301)443-8843

August, 1990

Material for use in preparation of Environmental Impact Statement

CONTENTS & GENERAL MAP

I. Introduction and General Information

A national marine sanctuary for the outer coast of the State of Washington has been mandated by the U.S. Congress. To identify the best possible site(s) for this sanctuary, an extensive region along Washington's coast was studied. The following is a presentation of material used to examine that region.

Included in this presentation are:

- A general description of the study region;
- Maps of pertinent information;
- An analysis of living marine resources that occur and are utilized off Washington; and
- Additional information describing various features of coastal lands adjacent to the study region (e.g., land uses, pollution discharges, demographics, etc.).

Information pertinent to areas under consideration for marine sanctuary status are arranged in sections. Within each section are associated figures and tables, and a "major features" page which summarizes notable material. Support material for findings presented in each section are listed in accompanying data appendices. In combination, these material provide a comprehensive examination of the outer coast of Washington and its resources.

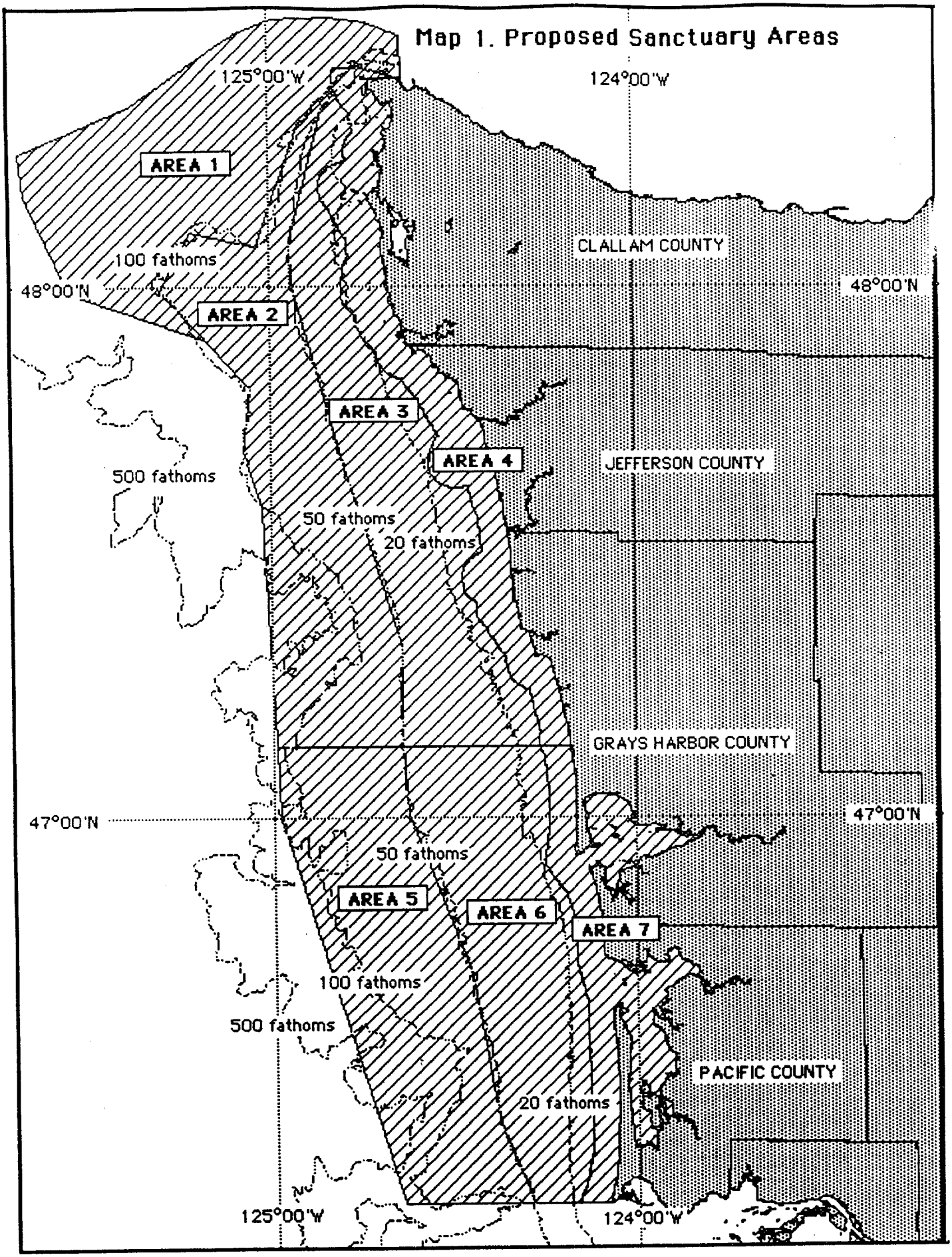
Description of the Study Region

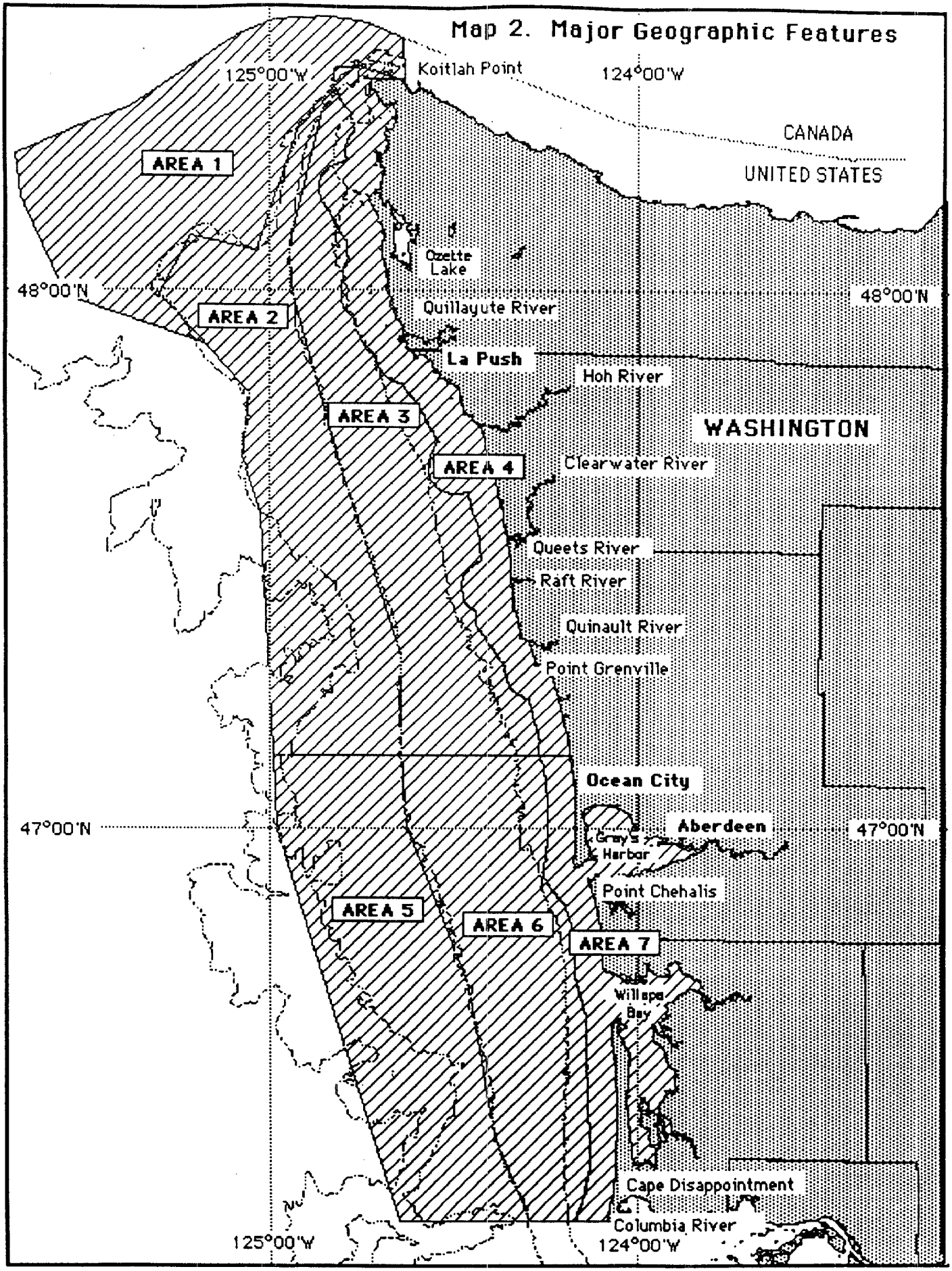
The study region is a nearly 6,000 sq s mi (square statute mile) area of the Pacific Northwest. It extends from the USA-Canada boundary at the mouth of the Strait of Juan De Fuca southward to the Washington shoreline at Koitlah Point, and from there along the shoreline to Cape Disappointment at the mouth of the Columbia River (Map 2). From Cape Disappointment, the region's boundary extends seaward to the continental shelf edge (100 fathom isobath) and then northward along the shelf edge to the Juan De Fuca Canyon (not indicated) and the USA-Canada boundary. Included in the study region are canyons off the southern and central portions of the coast, and a deep-water area known as "the plain" at the head of Juan De Fuca Canyon. The study region stops at the mean low water line and at stream/river mouths along the coast of Native American Tribal lands, but extends landward to the mean high tide line and upstream to the limit of tidal influence along the remaining coast.

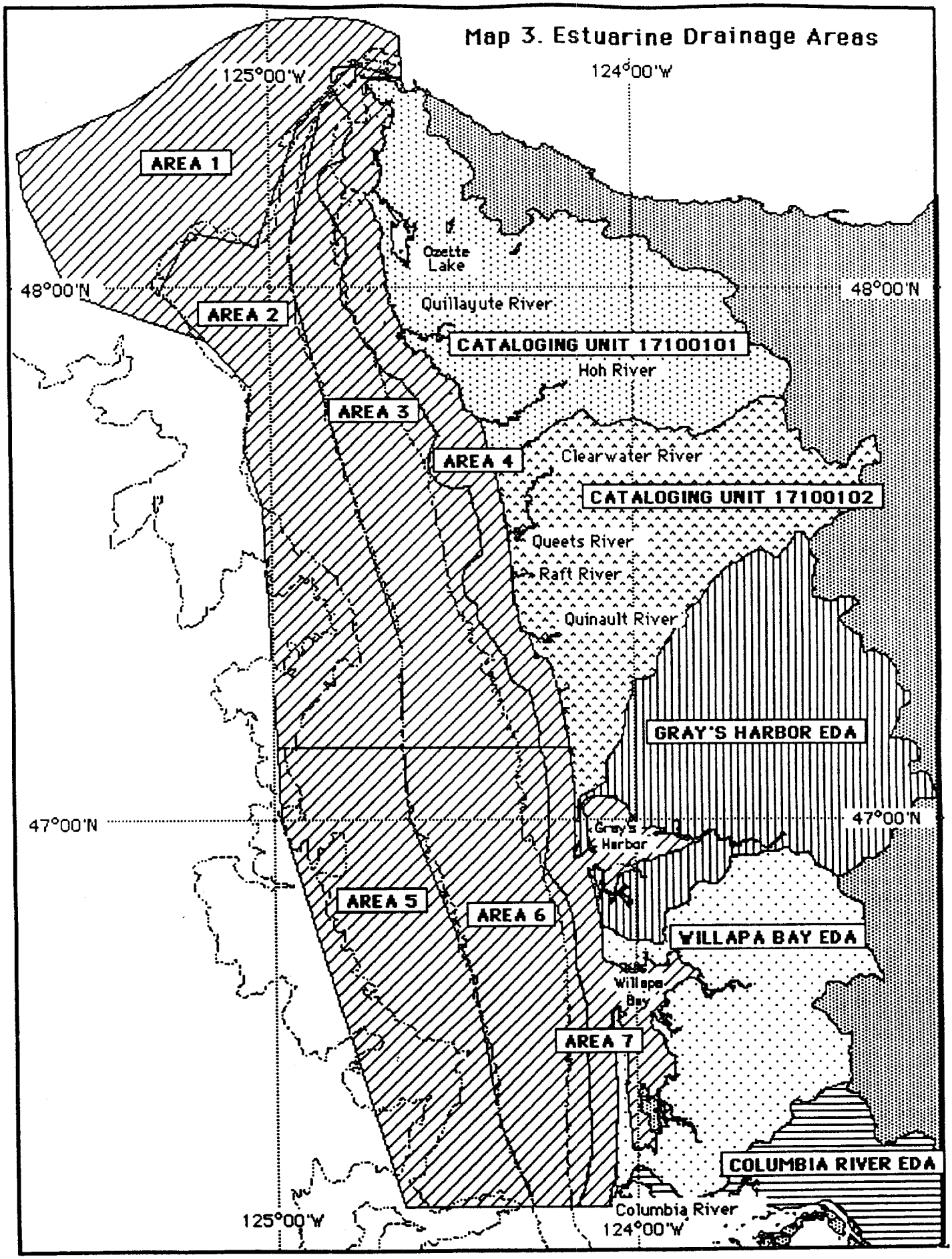
Area Descriptions. The study region was divided into seven areas to comparatively examine information for various segments of the marine region (Map 1), and note important sanctuary-related characteristics for each area.

Study Area	Area Description
1	An area at the head of the Juan De Fuca Canyon, including "the plain" and a small coastal area from Cape Flattery to Koitlah Point. It is bounded on the north by the USA-Canada marine boundary; on the east by a line extending from the USA-Canada line down to Koitlah Point; on the south from Cape Flattery to a point 3 n mi (nautical miles) offshore and then southwestward along the 100 fm isobath to the edge of the Juan De Fuca Canyon (about 35 n mi offshore); and on the west by a line extending northwestward to the USA-Canada boundary, approximately 40 n mi off Cape Flattery. Its surface area is roughly 1,000 sq s mi.
2	An offshore, deep water area that extends from 3 n mi off Cape Flattery southward along the 50 fm isobath to a line extending seaward from the southern boundary of the Copalis National Wildlife Refuge at the mouth of the Copalis River (not shown, but at Lat. 47° 07' N), seaward along the line to the 100 fm isobath, and northward along the 100 fm curve to about 3 n mi off Cape Flattery. Also included is a portion of the canyon off the Quinault River. The surface area of this study area is about 1,050 sq s mi.

Area	Area Description
3	The northern intermediate depth area shoreward of Area 2, extending out from 3 n mi off the coast out to the 50 fm isobath from off Cape Flattery south to the line extending seaward from the Copalis River mouth. It has a surface area of about 890 sq s mi.
4	An inshore area extending along the coast from Cape Flattery south to the southern boundary of the Copalis National Wildlife Refuge, and offshore to 3 n. mi. Most waters in this area are shallower than 20 fm, and the study area's surface area is about 521 sq s mi. Clallam County, Jefferson County, and a portion of Grays Harbor County are found shoreward of this study area, and rivers and streams which drain into this study area occur within the USGS (US Geological Survey) Estuarine Cataloging Units 17100101 and 102 (Map 3).
5	An offshore area between the 50 fm and 100 fm isobaths from the southern border of Area 2 southward to a line extending seaward from Cape Disappointment. This study area also includes a portion of the Grays Harbor Canyon and has a total surface area of nearly 1,100 sq s mi.
6	The southern intermediate depth study area between the 50 fm isobath and a line 3 n mi off the coast, from the southern boundary of Area 3 to the line extending seaward from Cape Disappointment. It has a total surface area of about 915 sq s mi.
7	The southern coastal area extending landward from 3 n mi offshore between the southern boundary of Area 4 and Cape Disappointment. This study area includes the significant estuaries of Grays Harbor and Willapa Bay and has a total surface area of about 400 sq s mi. Rivers and streams which drain into this study area occur within the USGS Estuarine Cataloging Units 17100104, 105, and 106 (Grays Harbor and Willapa Bay Estuarine Drainage Areas on Map 3).


Map 1. Proposed Sanctuary Areas
125°00'W
124°00'W
AREA 1
100 fathoms
48°00'N
CLALLAM COUNTY
AREA 2
AREA 3
AREA 4
JEFFERSON COUNTY
500 fathoms
50 fathoms
20 fathoms
GRAYS HARBOR COUNTY
47°00'N
AREA 5
AREA 6
AREA 7
PACIFIC COUNTY


Map 2. Major Geographic Features
125°00'W
Koitlah Point
124°00'W
CANADA
UNITED STATES
AREA 1
Ozette Lake
48°00'N
Quillayute River
AREA 2
La Push
Hoh River
AREA 3
WASHINGTON
AREA 4
Clearwater River
Queets River
Raft River
Quinault River
Point Grenville
Ocean City
47°00'N
Aberdeen
Gray's Harbor
Point Chehalis
AREA 5
AREA 6
AREA 7
Willapa Bay
Cape Disappointment
Columbia River
125°00'W
124°00'W


Map 3. Estuarine Drainage Areas
125°00'W
124°00'W
48°00'N
47°00'N
AREA 1
AREA 2
AREA 3
AREA 4
AREA 5
AREA 6
AREA 7
Ozette Lake
Quillayute River
CATALOGING UNIT 17100101
Hoh River
Clearwater River
CATALOGING UNIT 17100102
Queets River
Raft River
Quinault River
GRAY'S HARBOR EDA
Gray's Harbor
WILLAPA BAY EDA
Willapa Bay
COLUMBIA RIVER EDA
Columbia River

LAND USE

II Land use

- Lands adjacent to the study region are undeveloped, although logging is significant.

- Nearly all adjacent land is forested (94%). (See Figure 1.)

- Of the non-forested area, most is utilized for urban purposes, agriculture, and wetlands (each comprises about 2% of the total area in coastal counties).

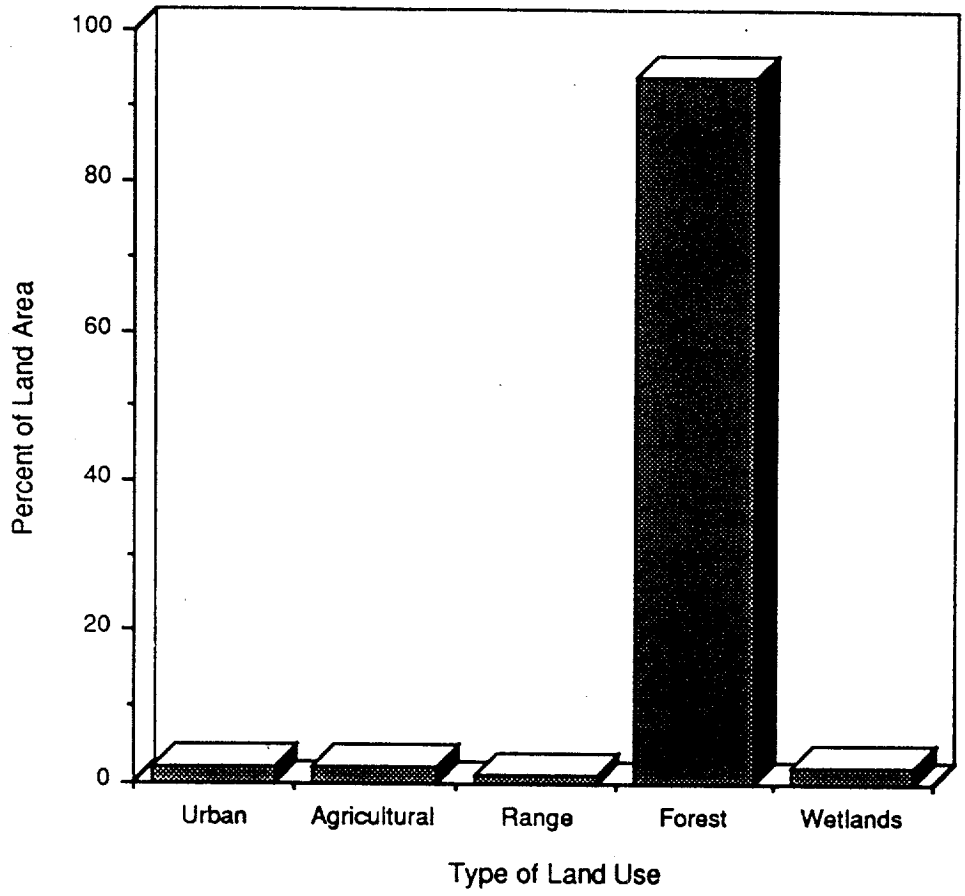


Figure 1. Land use for counties adjacent to the area under consideration for the Coastal Washington Marine Sanctuary.

Source: Strategic Assessment Branch. 1986. *West Coast land Use Data for NCPDI Counties* [data base]. Rockville, MD: Office of Oceanography and Marine Assessement/NOAA.

FRESHWATER INFLOW

III Freshwater Inflow

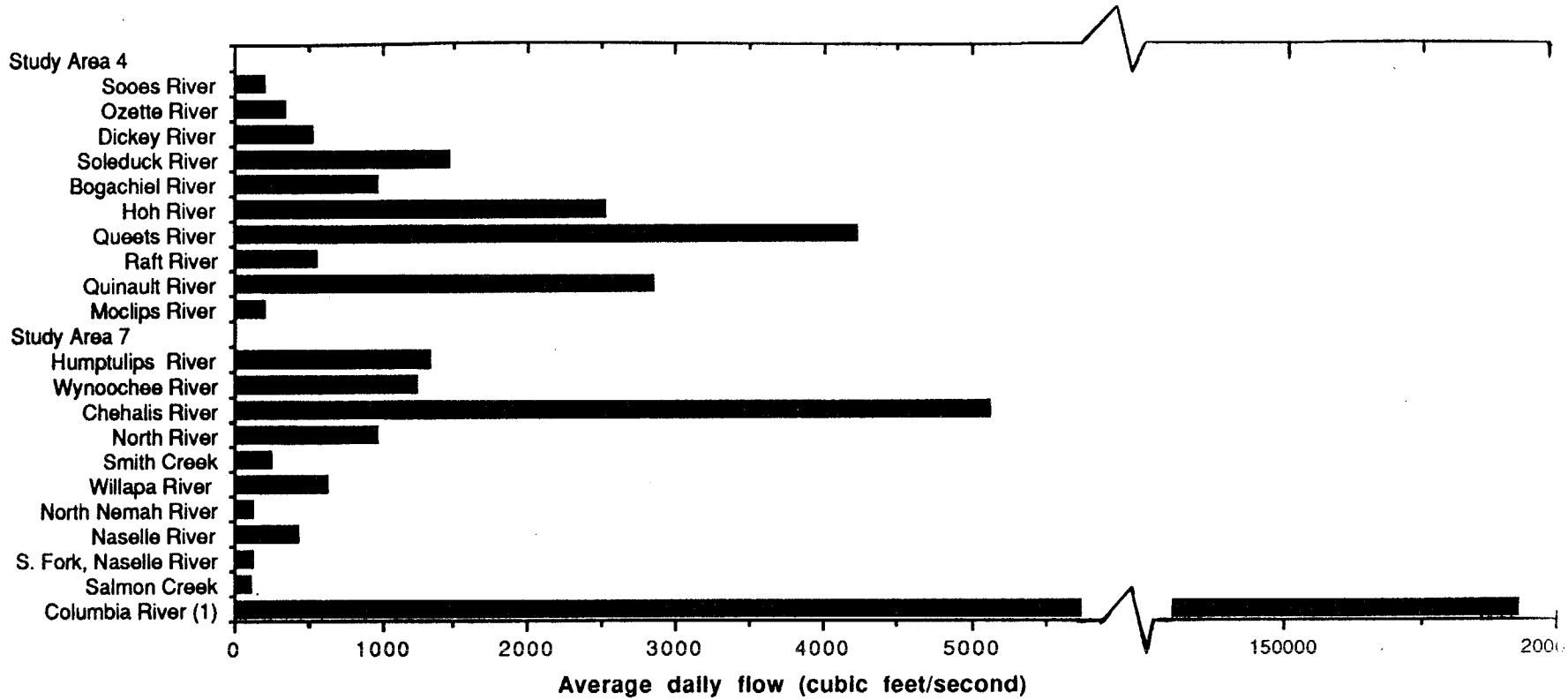
- When compared to other regions of the contiguous West Coast, freshwater flow from lands adjacent to the study region is relatively small.

- The Chehalis River, which discharges into Grays Harbor, has the largest flow of any river emptying into the study region, but its long term average flow is only about 2.5% of that for the Columbia River (Figure 2). (Measured upstream from a major Columbia River tributary, the Willamette River).

- Despite low overall amounts of freshwater flowing into the study region, volumes per square mile of drainage basin are high. High volumes per unit area result from small drainage basins with high rainfall and steep terrain.

- An example of high freshwater yield per unit area is the Quinault River which empties into Study Area 4. It ranks first in water yield (10.77 cfs per sq mi) for the 47 West Coast rivers that have been inventoried by NOAA. In contrast, the Columbia River ranks 40th (0.80 cfs per sq mi).

Flows and yields for several rivers discharging into the study region are presented in Appendix B, Table B.1; "cfs" is cubic feed per second.



(1) Information for Columbia River included for comparison purposes.

Figure 2. Freshwater discharges into study region waters.

Source: Personal communication with Steve Rohmann. Strategic Assessment Branch, OMA/NOAA.

POLLUTION DISCHARGES

IV Pollution Discharges and Sources

- Because of the undeveloped nature of land adjacent to areas under consideration for marine sanctuary, the entire study region is relatively unspoiled .

- Pollution from traditional sources (i.e., wastewater treatment plants, industry and urban runoff, etc.) is low (Figure 3).

- There are no major industrial polluters within Area 4, and only seven in Area 7. (See Table C.2 in Appendix C.).

- An exception to low pollution throughout the study region is the discharge from two pulp and paper mills in Area 7.

- Pesticide use along coastal Washington is very low relative to other areas of the West Coast (Figure 4).

- Summaries of pollution discharges for total volumes of nitrogen, lead, and all suspended solids combined indicate that with the exception of suspended solids discharged by paper mills, the greatest source of pollutants into study region waters is from backgroud material in natural forest runoff (Figures 5-7). Information for these pollutants and seven others are presented in Table C.1 of Appendix C

- Note: the above information relates to data from the early 1980s. More recently, there are indications that logging activity may have expanded considerably. Increases in logging of these lands would substantially increase many pollutant discharges, especially from clear cutting along river banks and estuary shorelines.

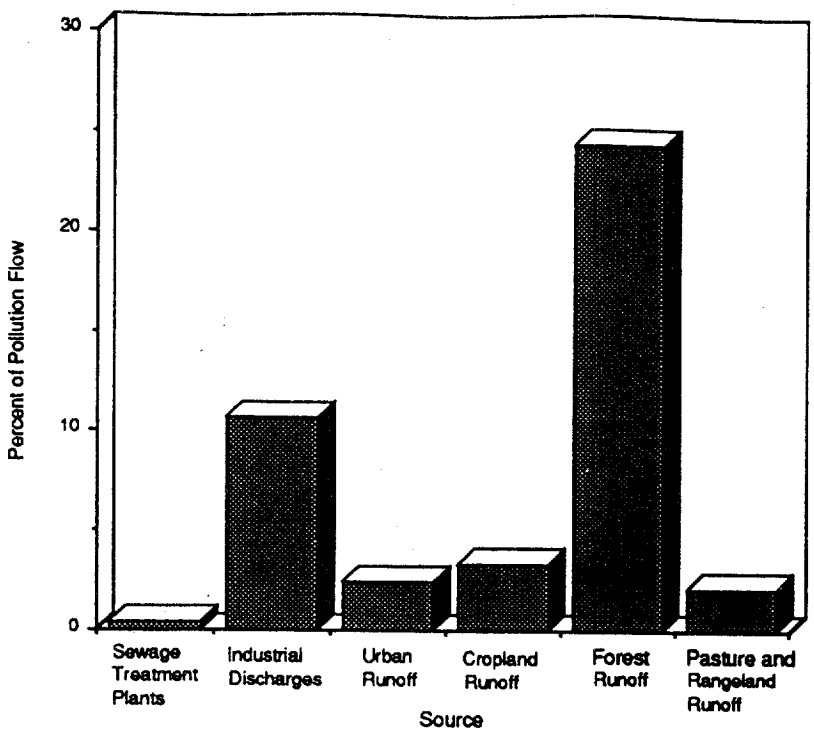


Figure 3. Pollution discharges by source (as percentage of U.S. West Coast totals) in counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary.

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD.

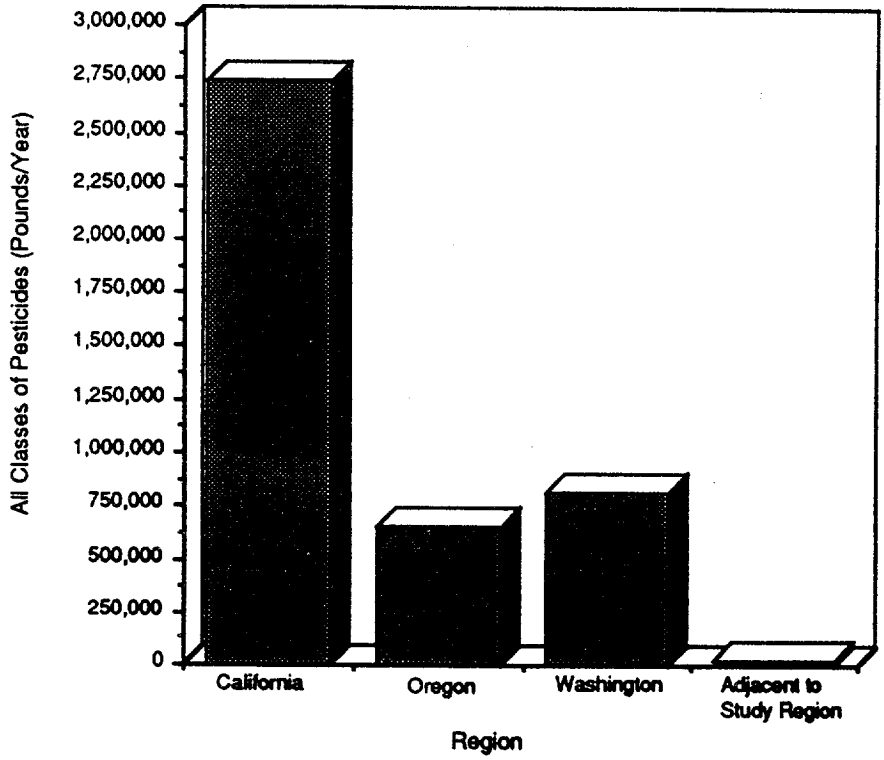


Figure 4. Pesticide use per year in West Coast states and on lands adjacent to areas under consideration for the Coastal Washington Marine Sanctuary.

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD.

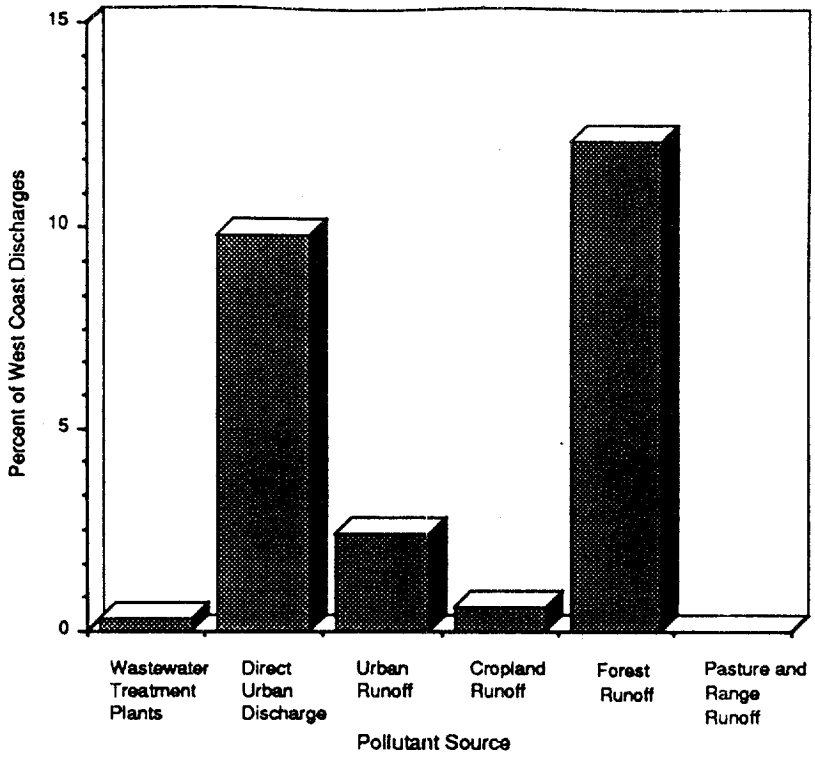


Figure 5. Total nitrogen discharged into counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary by source (as a percentage of the U.S. West Coast).

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD.

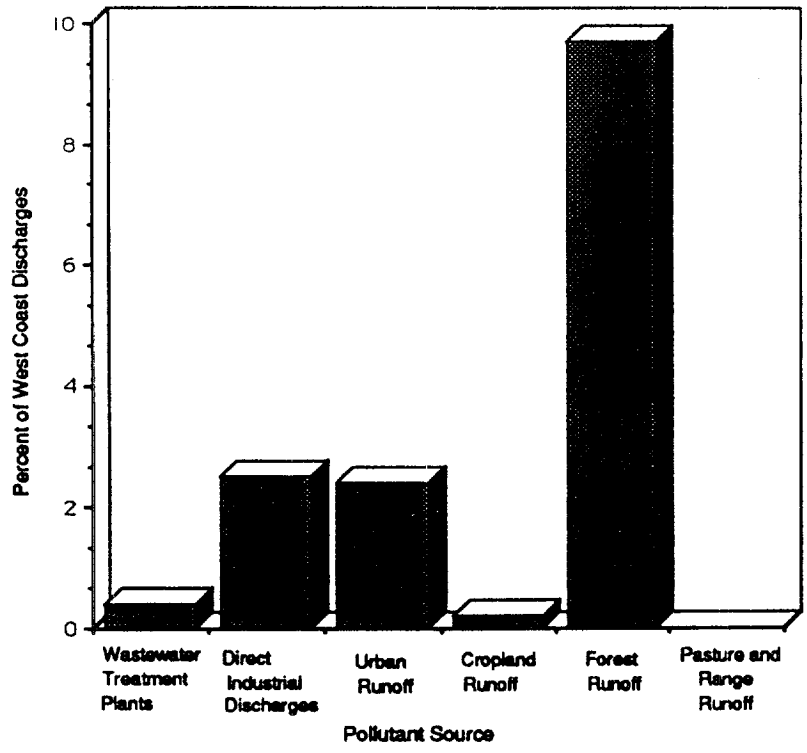


Figure 6. Total lead discharged into counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary, by source (as a percentage of U.S. West Coast discharges).

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD.

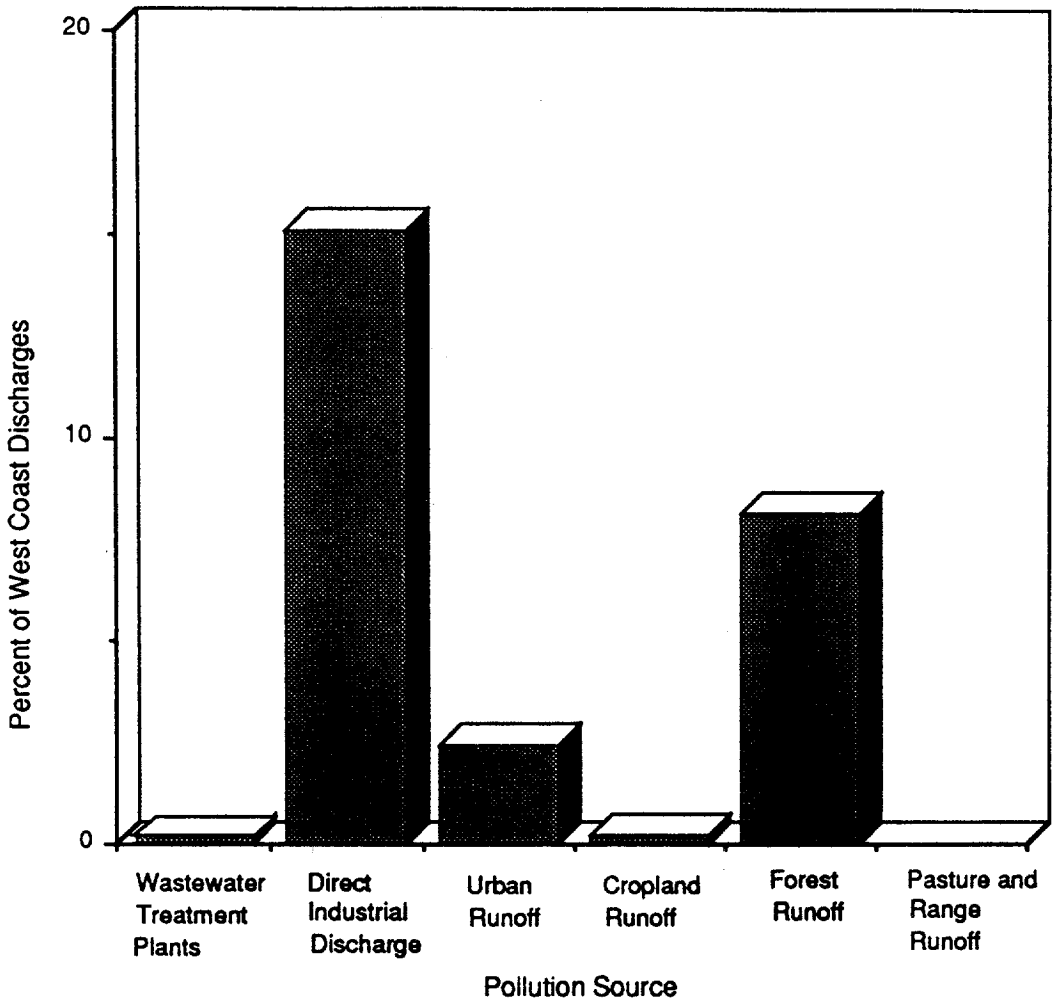


Figure 7. Total volume of all suspended solids discharged into counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary by source (expressed as a percentage of the U.S. West Coast total).

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD.

SOCIO-ECONOMIC PROFILE

V Socio-Economic Coastal Characteristics

- The human population within coastal areas adjacent to the sanctuary study region is low, slowly growing, and is projected to remain so (Figure 8).

- Most people in the study area are employed in manufacturing, whereas in all other coastal counties in the USA, most employment is in services (Figure 9). This is primarily the result of pulp and paper manufacturing and commercial fishing in the study region.

- Unemployment is high relative to most other areas in the Nation (Figure 10). This reflects seasonal employment associated with fishing, timber, and tourism.

- New construction in the area is low (Figure 11).

- Although similar to most other areas in Washington (Figure 12), property values for lands adjacent to the sanctuary study region are much lower than property values for other regions of the Coastal USA.

- Large tracts of land are publicly owned (e.g., 74% of Clallam and Jefferson counties).

- Counties adjacent to the study region contain only 10% of the total number of public recreation areas in the state of Washington, but these represent nearly 70% of statewide publicly owned acreage (Figure 13).

- There is a large tourist industry in the study area. For example, the Olympic National Park alone generates $560 million annually.

- The fishing industry is extremely important in the study region. Nearly two-thirds of the poundage and 37% of the value for Washington's commercial fisheries come from harvests within the sanctuary study region (Tables 1 and 2). (These statistics are for 1987 and 1988, and do not reflect landings from off other states and British Columbia. Detailed catch statistics are presented in Appendix E.)

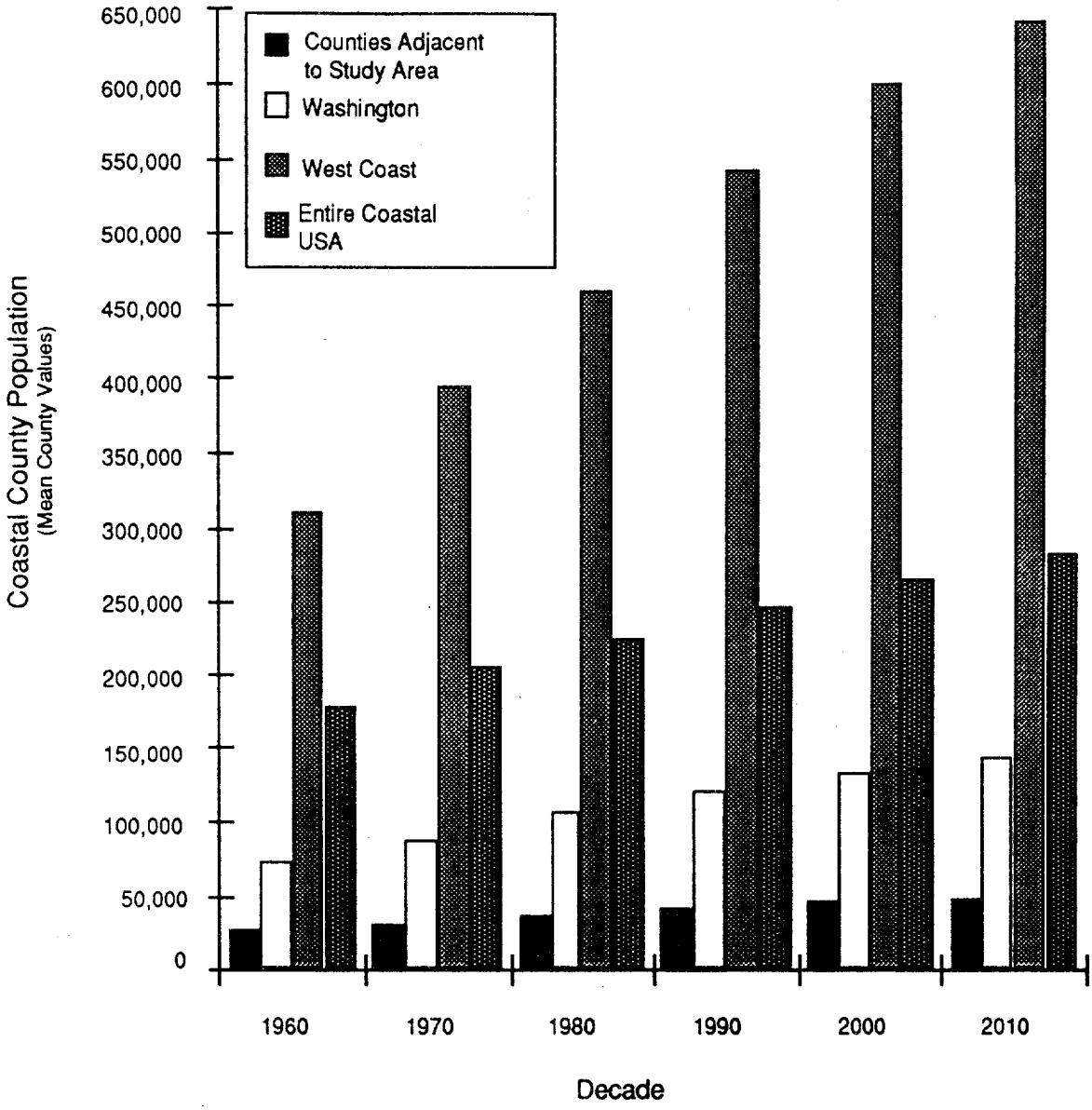


Figure 8. Population change for counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary, the State of Washington, the U.S. West Coast, and the entire coastal USA.

Source: Culliton, et al. 1990: 50 Years of Population Change Along the Nation's Coasts, 1960-2010. Strategic Assessment Branch, Office of Oceanography and Marine Assessments, Ocean Assessment Division, National Ocean Service, National Oceanic and Atmospheric Adminsitration, Rockville, MD.

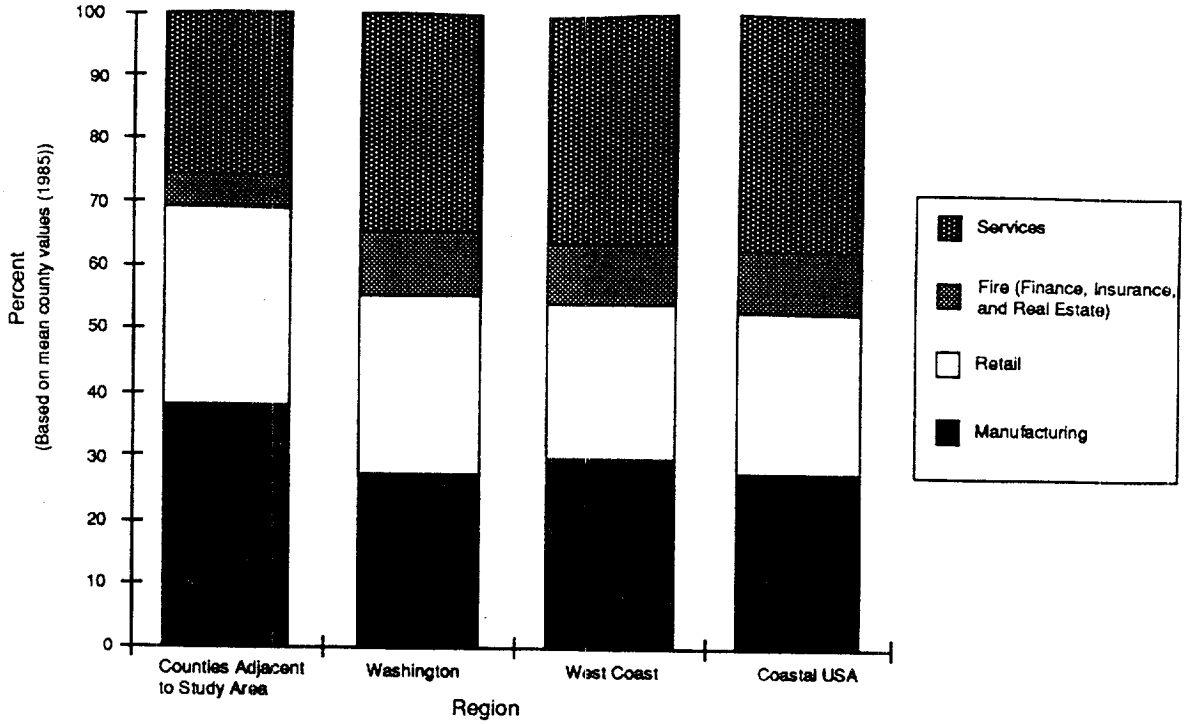


Figure 9. Employment by job sector for the counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary, the State of Washington, the U.S. West Coast, and the entire coastal USA.

Source: Culliton, et al. 1990: 50 Years of Population Change Along the Nation's Coasts, 1960-2010. Strategic Assessment Branch, Office of Oceanography and Marine Assessments, Ocean Assessment Division, National Ocean Service, National Oceanic and Atmospheric Adminsitration, Rockville, MD.

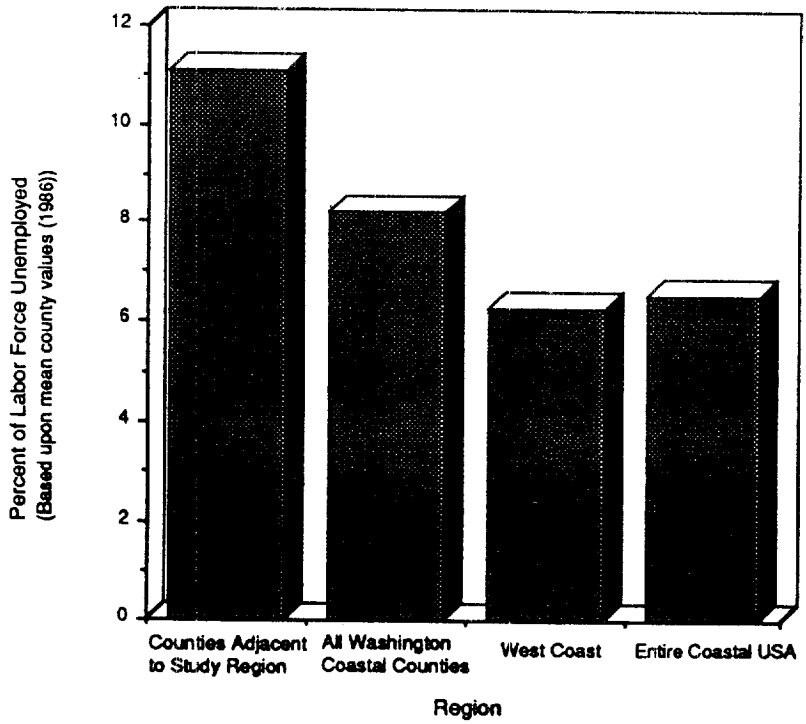


Figure 10. Annual unemployment for the counties adjacent to the areas under consideration for the Coastal Washington Marine Sanctuary , Washingtc coastal counties, the U.S. West Coast, and the entire coastal USA.

Sources: Bureau of the Census. 1980. *County and City Data Book*, 1988. U.S. Dept. of Commerce. Washington, D.C.: U.S. Gvt. Printing Office. 797 pp. + Appendicies.
Bureau of the Census, 1990. Building Permit Data Offering Information Package [data base]. Prepared by the Construction

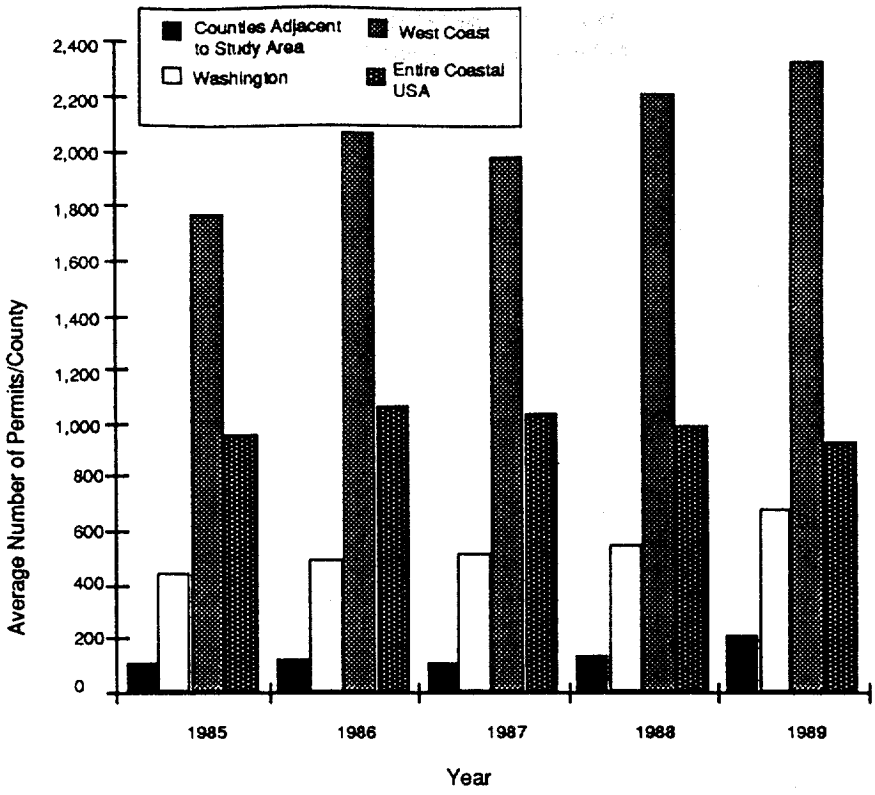


Figure 11. Construction permits (all types) by region and year, 1985-1989, in the counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary, the State of Washington, the U.S. West Coast, and the entire coastal USA.

Source: Culliton, et al. 1990: 50 Years of Population Change Along the Nation's Coasts, 1960-2010. Strategic Assessment Branch, Office of Oceanography and Marine Assessments, Ocean Assessment Division, National Ocean Service, National Oceanic and Atmospheric Adminsitration, Rockville, MD.

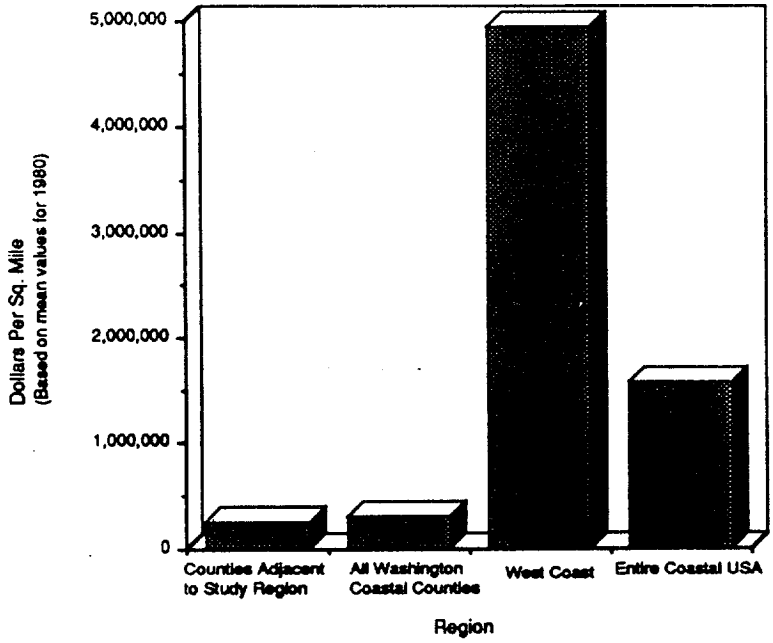


Figure 12. Average county real estate value for the counties adjacent to areas under consideration for the Coastal Washington Marine Sanctuary, the State of Washington, the U.S. West Coast, and the entire coastal USA.

Sources: Bureau of the Census. 1980. *County and City Data Book*, 1988. U.S. Dept. of Commerce. Washington, D.C.: U.S. Gvt. Printing Office. 797 pp. + Appendicies.
Bureau of the Census, 1990. Building Permit Data Offering Information Package [data base]. Prepared by the Construction Statistics Division, Building Permits Branch. Washington, D.C. U.S. Department of Commerce.
Slater Hall Information Products, Inc. 1988. *Populations Statistics* [data base]. Washington, D.C.: Slater Hall Information Products, Inc.

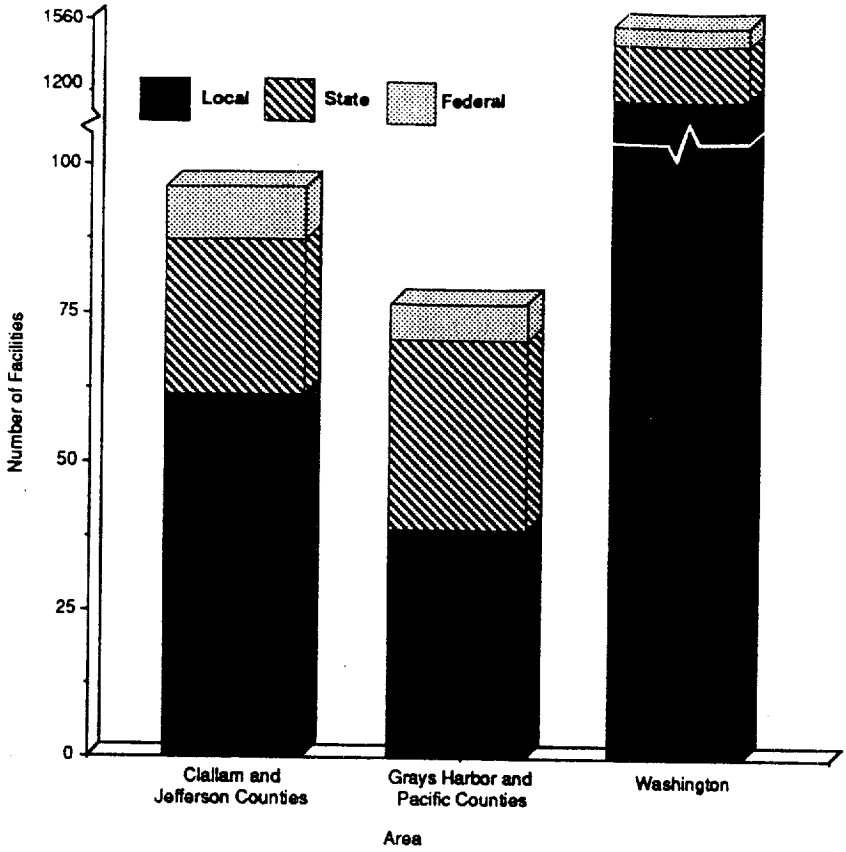


Figure 13a. Number of public recreational facilities adjacent to areas considered for the Coastal Washington Marine Sanctuary, and the entire state of Washington.

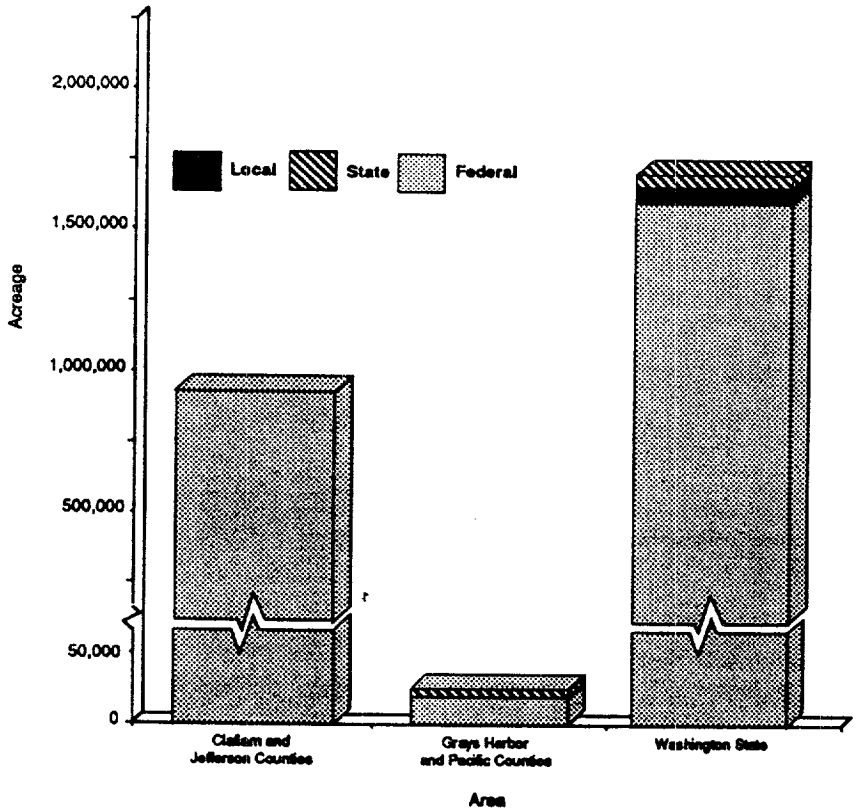


Figure 13b. Acreage of public recreational facilities adjacent to areas considered for the Coastal Washington Marine Sanctuary, and for the entire state of Washington.

Source: NOAA Inventory of Public Recreation Areas and Facilities, 1984. Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, National Ocean Service, National Oceanic and AtmosphericAdministration, Rockville, MD.

Table 1. Estimates of values and volumes for commercial harvests in the state of Washington (1) (2).

Species	Landed value	Pounds landed
Sockeye salmon **	$ 20,593,593	8,620,521
Coho salmon **	18,655,221	10,485,109
Chum salmon **	18,361,898	15,973,980
Chinook salmon **	16,586,065	8,454,675
Dungeness crab *	13,593,309	11,600,271
Pacific oyster **	10,991,082	8,606,887
Ocean pink shrimp	6,176,103	13,459,058
Sea urchins	5,749,167	6,224,967
Sablefish	4,447,218	6,127,331
Geoduck *	2,948,037	4,535,442
Manila clam *	2,926,049	3,506,203
Pacific cod	1,903,630	6,439,232
Widow rockfish	1,880,523	6,146,421
Yellowtail rockfish	1,291,100	4,306,187
Rockfish spp.	1,102,119	4,735,237
Others	13,053,223	4,691,591
Total	$140,258,337	123,913,112 lbs.

Table 2. Estimates of values and volumes for commercial harvests in areas under consideration for the proposed coastal Washington marine sanctuary (1).

Species	Landed value	Pounds landed
Dungeness crab *	$ 11,407,311	9,771,405
Pacific oyster **	7,551,846	5,930,458
Ocean pink shrimp	7,208,086	13,460,058
Chinook salmon **	5,052,149	2,593,888
Sablefish	4,407,200	6,119,654
Coho salmon **	3,039,474	1,547,717
Chum salmon**	1,927,083	1,681,745
Widow rockfish	1,880,523	6,146,421
Pacific cod	1,172,195	4,022,983
Albacore	1,090,613	1,320,249
Dover sole	956,236	3,745,539
Petrale sole	686,334	918,160
Lingcod *	636,334	1,898,565
Arrowtooth flounder	498,242	3,492,503
Others	4,676,854	19,942,025
Total	$ 52,190,480	82,591,370 lbs.

(1) Average of 1987 and 1988.
(2) Washington landings from other state's waters and from off British Columbia are excluded.
* Estuarine Associated Species (i.e., uses estuaries during one or more life stages)
** Estuarine Dependent Species (i.e., requires estuaries during one or more life stages)

Sources:

NMFS. 1989. State of Washington volumes and values for fish and shellfish landed in the state of Washington during 1988 [computer printout]. Seattle, WA.

NMFS. 1990. State of Washington volumes and values for fish and shellfish landed in the state of Washington during 1989 [computer printout]. Seattle, WA.

PacFIN. 1989. PFMC source report #002: Commercial groundfish landed catch (mt) for 1981-88, all areas. Seattle, WA.

WDF. 1989. Commercial catches for fish and shellfish species by statistical subarea and month for the state of Washington, 1987 and 1988 [computer printout]. Olympia, WA.

INVERTEBRATES

VI Information on Marine Invertebrates

- Both the comparative significance analysis of species distributions (Table 3) and the distributions analysis weighted by species abundance (Table 4) reveal that the inshore Areas 4 and 7 are the most important areas in the study region.

- Areas 4 and 7 contain beaches where the majority of the entire U.S. West Coast recreational harvests of razor clams are taken. An average of over 7.5 million razor clams were taken by nearly 1 million recreational clam diggers during 1960s and 1970s. More recently, razor clam populations have been reduced in size in Washington (due to disease); however, harvests from Washington beaches still account for about 70% of contiguous West Coast recreational catches (e.g., 6.2 million clams of the 8.7 million clams total for 1988 and 1989, combined).

- Areas 4 and 7 include Grays Harbor and Willapa Bay where harvests of Pacific oysters can account for over half of all oysters harvested along the entire U.S. West Coast. Harvests in these estuaries sometimes represent nearly one-fifth of nation wide harvests (Figure 14).

- More than three-quarters of the state's Dungeness crab catch is taken in Areas 4 and 7 and the shallow, shoreward portions of Areas 3 and 6.

- Pacific oyster, Dungeness crab, and ocean pink shrimp landings from areas under consideration for sanctuary status had combined landed values in 1987-88 of over $25 million (about 85% of statewide totals for harvests of these species off Washington).

- In addition to the significance of oyster harvests, landings for other shellfish in the study region represent:
  -- 32% of all contiguous US West Coast commercial crab harvests (1985-88 data);
  -- About 25% of all shrimp harvests (1985-88 data); and

Note: Also see Tables 1 and 2 (Commercial landings and values...) in Section V, Socio-economic Coastal Characteristics.

Table 3. Comparative significance of study areas based on the distributions of selected invertebrate species occurring off Washington.

INVERTEBRATES	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Weathervane Scallop	○	○	◉	○	◉	◉	○
Pacific Oyster 1/				○			◉
Pacific Geoduck	○			○			○
Fat Gaper	○			●			●
Pacific Gaper				○			◉
Pacific Razor 2/				◉			◉
Pacific Littleneck				○			◉
Manila Clam				○			◉
Pinto Abalone	○		○	◉			○
Giant Octopus	○	◉	◉	◉	○	●	●
Market Squid	◉	◉	◉	◉	◉	◉	◉
Red Squid	◉						
Northern Pink Shrimp	○	○	○		○	○	
Ocean Pink Shrimp 1/	◉	◉	◉		●	◉	○
Sidestripe Shrimp	●	○	○		○	○	
Coonstripe Shrimp	○						
Spot Shrimp	●	●	●	●	●	●	●
Bairdi Tanner Crab	○	○					
Dungeness Crab 1/	○	◉	◉	◉	◉	●	◉
Point Totals 3/	21	15	16	25	14	17	27

Legend:
○ Not Significant = 1
◉ Significant = 2
● Very Significant = 3
(Significance relative to species distribution along the contiguous U.S. West Coast)

1/ Commercially Important in Study Region.
2/ Recreationally Important in Study Region.
3/ A summary of point values (i.e. significance) associated with all species within an area.

Source: Strategic Assessment Branch. *West Coast North America Coastal Zones Strategic Assessment: Data Atlas*, Invertebrate and Fish Pre-publication Volume. Rockville, MD: National Oceanic and Atmospheric Administration.

Table 4. Comparative significance of study areas based on the relative abundance and importance of selected invertebrate species occurring off Washington.

INVERTEBRATES	Density Index	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Weathervane Scallop	4	4	4	8	4	8	8	4
Pacific Oyster	10				10			20
Pacific Geoduck	2	2			2			2
Fat Gaper	3	3			9			9
Pacific Gaper	3				3			6
Pacific Razor	5	5			10			10
Pacific Littleneck	3				3			6
Manila Clam	3				3			6
Pinto Abalone	1	1		1	2			1
Flat Abalone	1				2			
Giant Octopus	4	4	8	12	12	4	12	12
Market Squid	4	8	8	8	8	8	8	8
Red Squid	2	4						
Northern Pink Shrimp	1	1	1	1		1	1	
Ocean Pink Shrimp	10	20	30	20		30	20	10
Sidestripe Shrimp	2	6	2	2		2	2	
Coonstripe Shrimp	1	1						
Spot Shrimp	2	6	4	6	6	4	6	6
Baird Tanner Crab	1	1	1					
Dungeness Crab	10	10	20	30	20	20	30	20
Area (column) Total		71	78	88	94	77	87	120

Legend:

Density Index: Defined as the relative density or abundance of the species, based on commercial and recreational harvests. Rated 1 - 10, with 1 = rare, and 10 = highly abundant.

Key for Areas 1 - 7

21 - 30 = Very Significant. Species has broad areal coverage of the analysis area, and/or is abundant.

11 - 20 = Significant. Species has some areal coverage, and/or is present in some abundance.

0 - 10 = Not Significant. Species is either present or only occasionally occurs there; low, if any, abundance.

Source: Strategic Assessment Branch (SAB) analysis of the State of Washington commercial and recreational catch statistics in relation to species distribution maps in the NOAA *West Coast of North America, Coastal and Ocean Zones Strategic Assessment: Data Atlas*, Invertebrate and Fish pre-publication volume. NOAA, SAB, Rockville, MD.

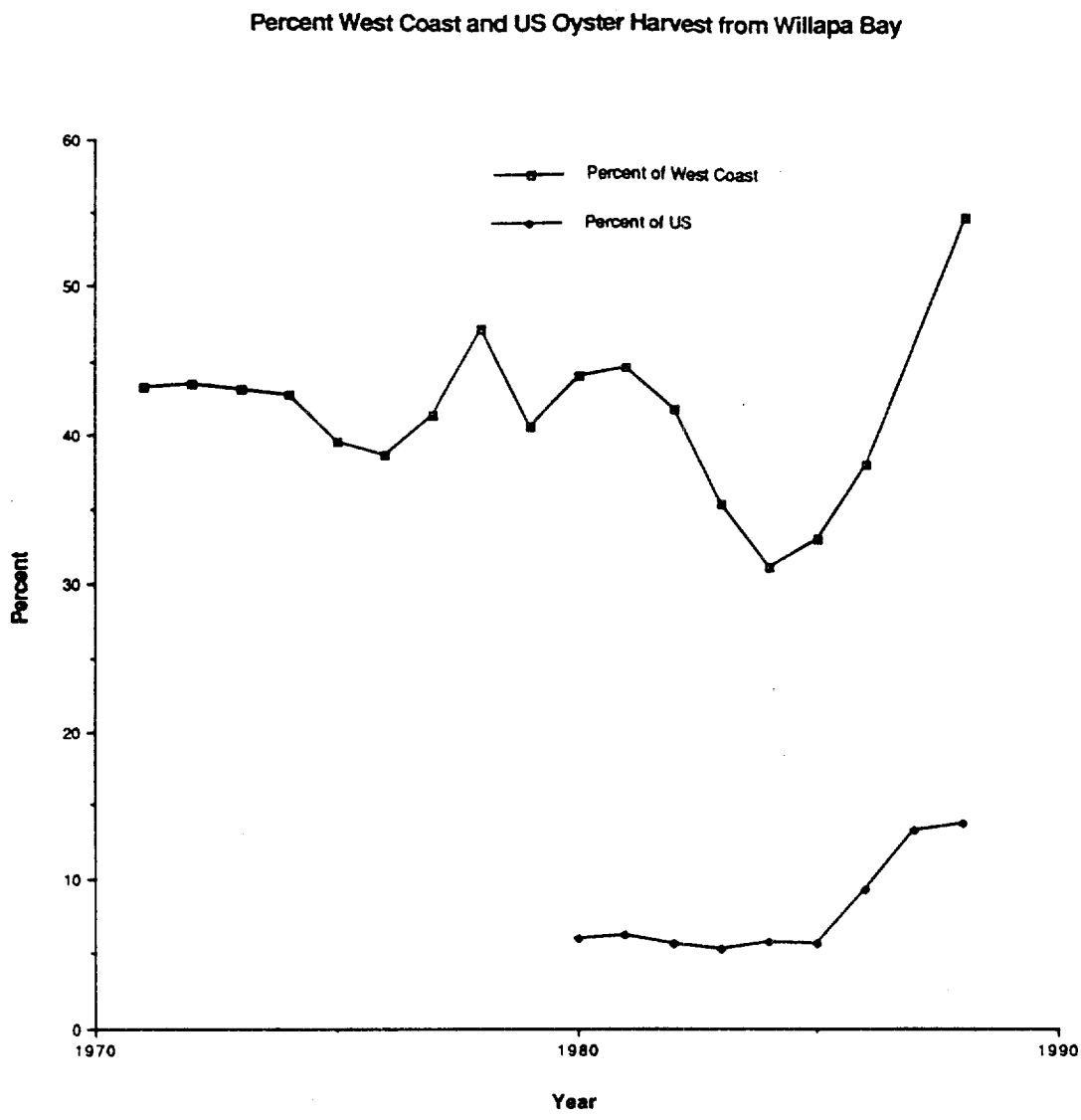


Figure 14. Percent of annual U.S. West Coast oyster harvests and nationwide harvests occurring in Willapa Bay.

Source:

Leonard, D. L. and D. A. Slaughter. 1990. The quality of shellfish growing waters on the West Coast of the United States. NOAA/SAB, Rockville, MD.

NMFS. 1898. State of Washington volumes and values for fish and shellfish landed in the state of Washington during 1988. NMFS/NW Region Headquarters, Seattle, WA.

WDF. 1989. Commercial catches for fish and shellfish species by statistical subarea and month for the state of Washington, 1987 and 1988. WDF, Olympia, WA.

Razor clams and the outer coast of Washington

The clam industry in Washington produces about 95% of U.S. West Coast landings. Although it now accounts for only a small fraction of harvest volumes nationwide, Washington was the leader of clam harvests for many years primarily because of its innovations in canning. Clams have always been a part of Washington culture, especially such species as the Pacific geoduck (or geoduc) and the razor clam. Harvests of the former comprise a significant portion of current commerical harvests, and the latter is the paramount recreational bivalve for the west coast of North America.

Razor clams are found primarily on open coast, sandy beaches of Study Area 7; many occur on Area 4 beaches also. This species normally occurs from low intertidal waters out to about depths of about 30 feet, and mostly from the low tide line to depths of less than 10 feet.

Since the 1960s, most razor clams have been taken by recreational diggers. During 1969-1974, annual recreational harvests for the contiguous West Coast averaged about 9.5 million clams; about 80% came from Washington beaches. Recreational harvests in Washington ranged between 7 million and 15 million clams at that time, but pathogen infestations and other natural calamities during the early 1980s severely decimated razor clam populations along Washington's coast. Since that time, populations have recovered somewhat and recreational digging has resumed. During 1988-89, about 3 million razor clams were annually taken by recreational diggers along Washington's coast; this amount represents over 70% of (contiguous) coastwide U.S. sport harvests.

Although extensive earlier this century, commercial harvests of razor clams now are minor in Washington. Annual harvests peaked at 3.2 million pounds of meats in 1915 and still averaged about 2 million pounds during the 1930s, but harvests substantially declined thereafter. By the 1970s, commercial harvests annually averaged less than 270,000 pounds; this reduced volume reflected natural and human-caused population declines, as well as ever-increasing recreational harvests. Harvests dropped to only a few thousand pounds annually by the early 1980s due to a variety of problems: El Nino-related temperature changes, the Mt. St. Helen eruption, and diseases. The resurgence of coastal Washington razor clam populations during the latter 1980s did not signal the return of notable commercial harvests; recreational harvests now dominate human use.

Sources:

Schink, T. J. K. A. McGraw, and K. K. Chew. 1983. Pacific coast clam fisheries. Washington State Sea Grant Technical Rep. 83-1. Univ. of Washington, Seattle, WA. 72 pp.

Leonard, D. L. and D. A. Slaughter. 1990. Quality of shellfish growing waters on the West Coast of the United States. NOAA, Natl. Ocean Serv., Strategic Assessments Branch, 6001 Executive Blvd., Suite 220, Rockville, MD. 52 pp.

Washington Department of Fisheries. 1983. 1982 Fisheries Statistical Report for the State of Washington. Compiled and edited by W. D. Ward and L. J. Hoines. Wash. Dep. Fish., Olympia, WA. 77 pp.

Washington Department of Fisheries. 1987. 1986 Fisheries Statistical Report for the State of Washington. Compiled and edited by W. D. Ward and L. J. Hoines. Wash. Dep. Fish., Olympia, WA. 89 pp.

Personal communication from D. Simons, Wash. Dep. of Fisheries, Montasano, WA.

Personal communication from T. Link, Oregon Dep. of Fisheries and Wildlife, Astoria, OR.

FISH

Table 5. Comparative significance of study areas based on the distribution of selected fish species occurring off Washington.

FISHES	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Spiny Dogfish 1/	◉	◉	●	●	●	●	●
Pacific Herring 1/	◉	◉	◉	●	●	●	●
Pacific Sardine	○	○	○		○	○	
Northern Anchovy	◉	◉	◉	●	●	●	●
Pink Salmon 1/ 2/	◉	◉	◉	●	●	●	●
Chum Salmon 1/ 2/	◉	◉	◉	●	●	●	●
Coho Salmon 1/ 2/ 3/	◉	◉	◉	●	●	●	●
Sockeye Salmon 2/	◉	◉	◉	●	●	●	●
Chinook Salmon 1/ 2/ 3/	●	◉	●	●	●	●	●
Steelhead 3/ 4/	◉	◉	◉	●	●	●	●
Pacific Cod 1/	◉	◉	◉	●	●	●	●
Walleye Pollock	●	◉	◉	●	●	●	●
Pacific Hake 1/	◉	◉	◉	○	●	◉	○
Jack Mackerel	◉	◉	◉	●	●	●	●
Albacore Tuna 1/	○						
Chub Mackerel	○	○	○	○	○	○	○
Swordfish	○	○	○	○	○	○	○
Striped Bass	○			○			○
Pacific Bonito	○	○	○		○	○	
California Halibut	○	○	○	○	○	○	○
Pacific Barracuda	○	○	○	○	○	○	○
Yellowtail	○	○	○	○	○	○	○
Pacific Ocean Perch 1/	◉	◉	○	○	●	○	○
Widow Rockfish 1/	◉	◉	◉	◉	●	●	◉
Sablefish 1/	◉	◉	○	○	●	○	○
Lingcod 1/ 3/	●	◉	●	●	●	●	●
Pacific Halibut 1/ 3/	◉	◉	●	○	●	●	○
English Sole 1/	◉	◉	●	○	●	●	○
Flathead Sole	◉	◉	◉	○	●	●	○
Petrale Sole 1/	◉	◉	●	○	●	●	○
Starry Flounder 1/	○	○	◉	◉	○	●	●
Dover Sole 1/	◉	●	●	○	●	●	○
Arrowtooth Flounder 1/	◉	●	●	○	●	●	○
Point Totals 5/	**69**	**66**	**66**	**61**	**69**	**67**	**51**

Legend:
- ○ Not Significant = 1
- ◉ Significant = 2
- ● Very Significant = 3

(Significance relative to species distribution along the contiguous U.S. West Coast)

1/ Commercially Important in Study Region.
2/ Anadromous Species. Presence in study area is limited to small out-migrating juveniles; larger, foraging juveniles; and nearly mature fish returning to rivers to spawn.
3/ Recreationally Important in Study Region.
4/ Anadromous Species. Unlike salmon, steelhead adults are also present.
5/ A summary of point values (i.e. significance) associated with all species within an area.

Source: Strategic Assessment Branch (SAB) analysis of State of Washington commerical and recreational catch statistics in relation to species distribution maps present in the NOAA *West Coast North America Coastal Zones Strategic Assessment: Data Atlas*, Invertebrate and Fish Pre-publication Volume. NOAA, SAB, Rockville MD.

VII Information on Marine Fishes

- Both the comparative significance analysis of species distributions (Table 5) and the analysis weighted by species abundance (Table 6) reveal that offshore and intermediate areas under sanctuary consideration (Areas 1,2,3,5, and 6) generally are more significant for marine fishes than inshore areas (Areas 4 and 7).

- Using commercial harvests as a means of assessing the significance of fish stocks within the proposed sanctuary region relative to other parts of the contiguous U.S. West Coast, the following is noted:
  --About 15% of all West Coat groundfish harvests come from the sanctuary study region (based on 1987-1988 data); and
  --Nearly 13% of all salmon harvests come from the region (1988-1990).

- When looking at commercial harvests, offshore Areas 1 and 5 were the most important. More than two-thirds of annual 1987-88 study region harvests came from these areas for the following species:
  —Pacific ocean perch
  —Lingcod
  —English sole
  —Dover sole
  —Pacific cod, and
  —Sablefish.

- Area 5, alone, produced the majority of harvests of widow rockfish.

- Although non-coastal areas scored highest in the comparative significance analyses, the importance of coastal waters for marine fishes is underscored by the association of many species with estuarine habitats:
  —Four of the top ten fishes commercially harvested along the outer coast of Washington are either estuarine-associated (i.e., they use estuaries during some time in their lives) or estuarine-dependent (i.e., they require estuaries to complete their life cycles). (Examples of estuarine associated/dependent species are chinook, coho, and chum salmon, and lingcod) (Table 2) .
  —The top four recreational species (chinook and coho salmon, steelhead, and lingcod) for Washington all utilize estuaries, at least as juveniles.

Note: Also see Tables 1. and 2. (Commercial landings and values...) in Section V, Socio-economic Coastal Characteristics.

Table 6. Comparative significance of study areas based on the relative abundance and importance of selected fish species occurring off Washington.

FISHES	Density Index	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Spiny Dogfish	5	15	15	15	10	15	15	10
Pacific Herring	5	10	10	10	10	10	10	15
Pacific Sardine	1	1	1	1		1	1	
Northern Anchovy	5	10	10	10	10	10	10	10
Pink Salmon	7	14	14	14	14	14	14	14
Chum Salmon	7	14	14	14	14	14	14	14
Coho Salmon	10	30	20	20	30	20	30	30
Sockeye Salmon	5	15	10	10	15	10	10	10
Chinook Salmon	10	30	20	30	30	20	30	30
Steelhead	8	24	24	24	24	24	24	24
Pacific Cod	7	21	21	21	14	21	21	14
Walleye Pollock	4	12	12	12	8	12	12	8
Pacific Hake	8	16	16	16	8	16	16	8
Jack Mackerel	3	6	6	6	6	6	6	6
Albacore Tuna	2	15						
Chub Mackerel	1	1	1	1	1	1	1	1
Striped Bass	1	1			1			1
Pacific Bonito	1	1	1	1		1	1	
California Halibut	1	1	1	1	1	1	1	1
Pacific Barracuda	1	1	1	1	1	1	1	1
Yellowtail	1	1	1	1	1	1	1	1
Pacific Ocean Perch	6	18	18	6	6	18	6	6
Widow Rockfish	9	18	27	27	18	27	27	18
Sablefish	8	24	24	8	8	24	8	8
Lingcod	10	30	30	30	30	30	30	30
Pacific Halibut	4	12	12	12	4	12	12	4
English Sole	5	10	15	15	5	15	15	5
Flathead Sole	2	6	6	6	2	6	6	2
Petrale Sole	6	2	3	3	1	3	3	1
Starry Flounder	5	5	5	10	15	5	10	15
Dover Sole	6	18	18	18	6	18	18	6
Arrowtooth Flounder	5	10	15	15	5	15	15	5
Area (column) total		379	371	356	296	371	361	298

Legend:

Density Index: Defined as the relative density or abundance of the species, based on commercial and recreational harvests. Rated 1 - 10, with 1 = rare, and 10 = highly abundant.

Key for Areas 1 - 7

21 - 30 = Very Significant. Species has broad areal coverage of the analysis area, and/or is abundant.

11 - 20 = Significant. Species has some areal coverage, and/or is present in some abundance.

0 - 10 = Not Significant. Species is either present or only occasionally occurs there; low, if any, abundance.

Source: Strategic Assessment Branch (SAB) analysis of the State of Washington commercial and recreational catch statistics in relation to species distribution maps in the NOAA *West Coast of North America, Coastal and Ocean Zones Strategic Assessment: Data Atlas*: Invertebrate and Fish Pre-publication Volume, NOAA, SAB, Rockville, MD

BIRDS

VIII Information on Marine Birds

- Coastal Areas 4 and 7 standout from other areas under consideration for sanctuary status when distributions of marine birds are examined (Table 7). Examples follow.

- Lands adjacent to Area 7 (around Grays Harbor) contain one of only two major concentrations of adult bald eagles along the contiguous U.S. West Coast.

- Only two major colonies of rhinocerous auklet (>20,000 birds) occur within the contiguous U.S.A. One occurs along the coast of Area 4 and the other is found in the adjacent Strait of Juan De Fuca.

- Only two large colonies of tufted puffins (>1,000 birds) occur within the contiguous U.S. One is found along the coast of Area 4.

- Grays Harbor and Willapa Bay in Area 7 are final staging areas for shorebird migrations during early spring.

The following relate to seabird colonies:

- Seabird populations in Washington represent 12% of the contiguous U.S. West Coast total of 4.5 million birds (Table 8).

- In toto, over 500,000 seabirds occur in nesting colonies within Washington. Nearly 70% of these occur along the outer coast; over 325,000 seabirds are found in Area 4 and about 45,500 are present in colonies in Area 7.

- Nesting colonies along the outer coast of Washington (Figure 15) contain more than 50% of contiguous U.S. West Coast total populations for the following species:
  —Fork-tailed storm-petrel
  —Caspian tern
  —Cassin's auklet
  —Tufted puffin.

Table 7. Estimates of seabird populations in areas considered for the coastal Washington marine sanctuary.

Species	Life Stage	Estimates for		Estimates by State			Total for Contiguous West Coast
		Area 4	Area 7	Washington	Oregon	California	
Fork-tailed Storm-petrel *Oceanodroma furcata*	Adults Juveniles	2,318 1,391	0 0	3,878 2,327	400 240	410 246	4,688 2,813
Leach's Storm-petrel *Oceanodroma leucorhoa*	Adults Juveniles	25,298 15,179	0 0	35,700 21,420	435,458 261,275	9,870 5,922	481,028 288,617
Ashy Storm-petrel *Oceanodroma homochroa*	Adults Juveniles	0 0	0 0	0 0	0 0	3,854 2,312	3,854 2,312
Brown Pelican *Pelecanus occidentalis*	Adults Juveniles	0 0	0 0	0 0	0 0	2,690 1,614	2,690 1,614
Double-crested Cormorant *Phalacrocorax auritus*	Adults Juveniles	1,276 2,552	916 1,832	3,296 6,592	3,964 7,928	5,204 10,408	12,464 24,928
Brandt's Cormorant *Phalacrocorax penicillatus*	Adults Juveniles	458 1,053	96 221	554 1,274	22,730 52,279	59,960 137,908	83,244 191,461
Pelagic Cormorant *Phalacrocorax pelagicus*	Adults Juveniles	2,398 5,515	240 552	4,866 11,192	10,999 25,298	12,100 27,830	27,965 64,320
Black Oystercatcher *Haematopus bachmani*	Adults Juveniles	194 213	0 0	334 367	358 394	358 394	1,050 1,155
Glaucous-winged /Western Gull *Larus glaucescens/Larus occidentalis*	Adults Juveniles	8,147 13,850	8,228 13,988	39,441 67,050	16,592 10,600	43,060 78,753	92,001 156,402
Caspian Tern *Sterna caspia*	Adults Juveniles	0 0	7,918 11,085	7,918 11,085	0 0	1,480 2,072	9,398 13,157
Least Tern *Sterna antillarum*	Adults Juveniles	0 0	0 0	0 0	0 0	2,472 2,719	2,472 2,719
Common Murre *Uria aalge*	Adults Juveniles	30,780 18,468	0 0	30,780 18,468	426,280 255,768	351,336 210,802	808,396 485,038
Pigeon Guillemot *Cepphus columba*	Adults Juveniles	552 552	69 69	4,270 4,270	4,996 4,996	13,886 13,886	23,152 23,152
Cassin's Auklet *Ptychoramphus aleuticus*	Adults Juveniles	87,599 52,559	0 0	87,600 52,560	100 60	63,400 38,040	151,100 90,660
Rhinoceros Auklet *Cerorhinca monocerata*	Adults Juveniles	24,010 14,406	0 0	60,814 36,488	1,000 600	1,703 1,022	63,517 38,110
Tufted Puffin *Fratercula cirrhata*	Adults Juveniles	18,051 10,831	0 0	23,342 14,005	5,031 3,019	266 160	28,639 17,183
TOTAL - Adults		192,934	17,467	263,352	911,316	528,989	1,703,657
TOTAL - Juveniles		133,886	27,747	272,535	636,029	1,926,276	2,834,839
TOTAL - Overall		326,820	45,214	535,887	1,547,345	2,455,265	4,538,496

Sources:

Sowls, A. L., A. R. DeGange, J. W. Nelson, and G. S. Lester. 1980. Catalog of California seabird colonies. U.S. Fish and Wildl. Serv., Biol. Serv. Program. FWS/OBS 80/37.

Massey, B. W. 1988. California least tern field study, 1988 breeding season. Cal. Dept. Fish and Game Contract FG 7660, Cal. State Univ., Long Beach, CA.

Speich, S. M. and T. R. Wahl. 1989. Catalog of Washington seabird colonies. U.S. Fish and Wildl. Serv., Biol. Rpt. 88(6).

Carter, E. R., D. L. Jaques, C. S. Strong, G. J. McChesney, M. W. Parker, and J. E. Takekawa. In prep. Survey of seabird colonies in northern and central California. U.S.Fish and Wildl. Serv., Dixon, CA.

Strategic Assessment Branch. 1990. Cmas (Computer Mapping and Analysis System) analysis of seabird colonies for the west coast of North America. NOAA/SAB, Rockville, MD.

Personal communications from R. Lowe for Oregon information.

Table 8. Comparative significance of study areas based on the distributions of selected marine bird species occurring off Washington.

MARINE BIRDS	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Pacific Loon	○	○	●	●		●	●
Western & Clark's Grebes				○			●
Northern Fulmar 1/2/	●	●	●		●	●	
Sooty Shearwater 1/2/	●	○	○	○	○	●	○
Brown Pelican	○	○	○	○	○	○	○
Brandt's Comorant	○			●			●
Brant				○			● 3/
Surf Scoter 2/	○	○	●	● 3/		○	○
Sanderling 2/				●			● 3/
Bald Eagle				●			●
Red Phalarope	○	●	●	●	●	●	●
California Gull	○	○	○	○	○	○	○
Western Gull	○	○	○	○	○	○	●
Glaucous-winged Gull	○	○	●	●	●	●	●
Black-Legged Kittiwake 1/2/	●	●	●	●	●	●	●
Common & Thick Billed Murres 4/	●	○	●	●	●	●	●
Ancient Murrelet 2/	●	○	○	○	○	○	○
Cassin's Auklet	○	○	○	○	○	○	○
Rhinocerous Auklet	●	●	●	●	●	●	●
Tufted Puffin	●	●	●	●	●	●	●
Point Totals 5/	26	23	26	33	23	27	36

○ Not Significant = 1
● Significant = 2
● Very Significant = 3

(Significance relative to species distribution along the contiguous U.S. West Coast.)

Source: Strategic Assessment Branch (SAB). *West Coast of North America Coastal and Ocean Zones Strategic Assessment: Data Atlas*, Marine Birds Pre-publication Volume. NOAA, SAB, Rockville, MD.

FOOTNOTES:
1/ Pelagic seabird.
2/ Uses Region as a non-breeding, wintering area.
3/ Possible staging area for spring migrations.
4/ Mainly present during winter.
5/ A summary of point values (i.e. significance) associated with all species within an area.

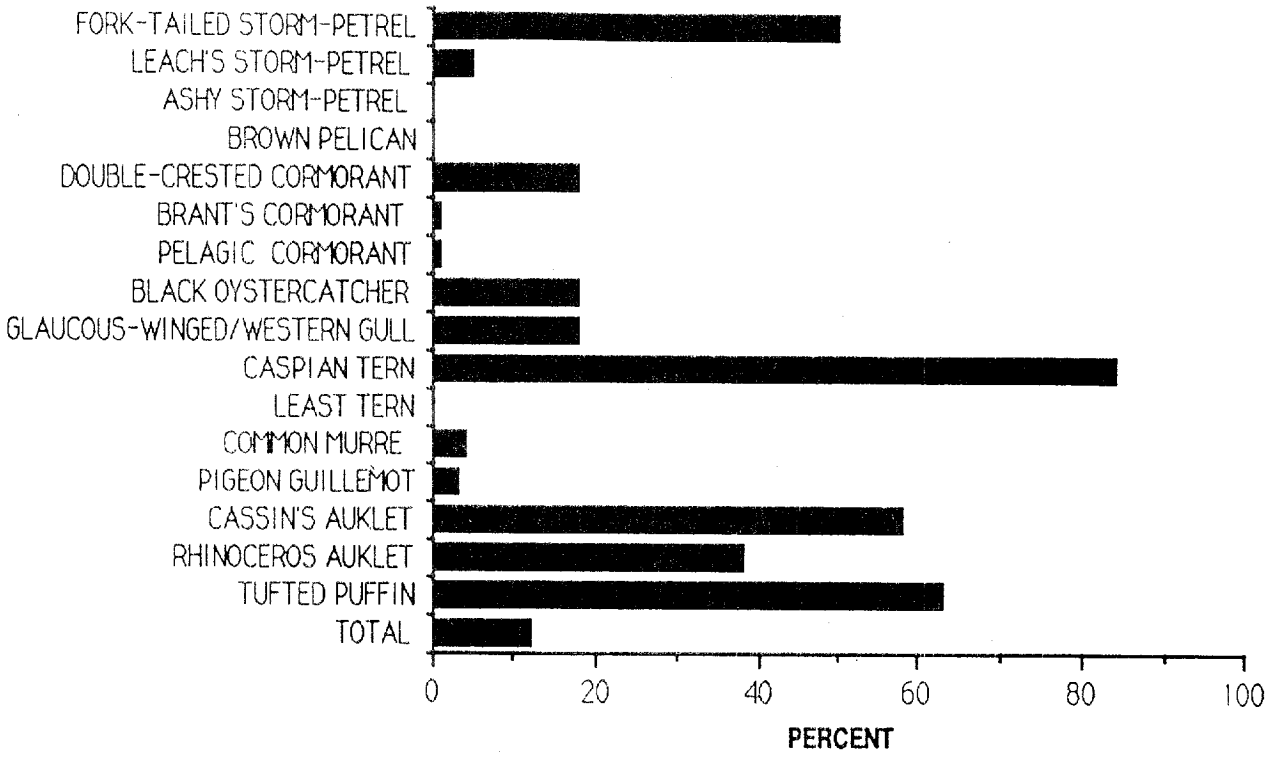


Figure 15. Percentages of contiguous U.S. West Coast seabird populations present within coastal Washington areas under consideration for marine sanctuary status.

Sources:

Sowls, A. L., A. R. DeGange, J. W. Nelson, and G. S. Lester. 1980. Catalog of California seabird colonies. U.S. Fish and Wildl. Serv., Biol. Serv. Program. FWS/OBS 80/37.

Massey, B. W. 1988. California least tern field study, 1988 breeding season. Cal. Dept. Fish and Game Contract FG 7660, Cal. State Univ., Long Beach, CA.

Speich, S. M. and T. R. Wahl. 1989. Catalog of Washington seabird colonies. U.S. Fish and Wildl. Serv., Biol. Rpt. 88(6).

Carter, E. R., D. L. Jaques, C. S. Strong, G. J. McChesney, M. W. Parker, and J. E. Takekawa. In prep. Survey of seabird colonies in northern and central California. U.S.Fish and Wildl. Serv., Dixon, CA.

Strategic Assessment Branch. 1990. Cmas (Computer Mapping and Analysis System) analysis of seabird colonies for the west coast of North America. NOAA/SAB, Rockville, MD.

Personal communications from R. Lowe for Oregon information.

MAMMALS

IX Information on Marine Mammals

- A comparative significance analysis of marine mammal distributions (Table 8) suggests that offshore areas under consideration for marine sanctuary status (Areas 1, 2, and 5) are more important for marine mammal distributions than other areas.

- In general, most of the region under consideration for sanctuary status occurs within migration pathways for several species.

- A major adult summer area for the endangered fin whale occurs along the continental slope seaward of the study area.

Table 9. Comparative significance of study areas based on the distributions of selected marine mammal species occurring off Washington.

MAMMALS	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Sea Otter 1/	○	○	○	●	○		
Northern Fur Seal 2/	◉	◉			●		
Northern Sea Lion	●	●	●	●	●	●	●
California Sea Lion 3/	●	●	●	●	●	●	●
Northern Elephant Seal 4/	●	●	●	●	●	●	●
Harbor Seal 5/	○	◉	◉	●	◉	◉	●
Killer Whale	●	●	●	●	●	●	●
Northern Right Whale Dolphin	○	◉			●		
Pacific White-side Dolphin	●	●	●		●	●	
Harbor Porpoise 6/	◉	○	◉	◉	○	●	●
Sperm Whale 7/	●	●			●		
Cuvier's Beaked Whale	◉	◉			●		
Baird's Beaked Whale	●	●			●		
Stejneger's Beaked Whale	◉	◉			●		
Hubb's Beaked Whale	◉	◉			●		
Gray Whale 8/	●	●	●	●		●	●
Right Whale 7/ 9/	●	●	●	●	●	●	●
Humpback Whale 7/	◉	◉	◉	◉	◉	◉	◉
Minke Whale 7/ 10/	◉	◉	◉	◉	◉	◉	◉
Fin Whale 7/ 11/	●	●	●	●	●	●	●
Blue Whale 7/	◉	◉	◉	◉	◉	◉	◉
Risso's Whale	●	●			●	○	
Dall's Porpoise	●	●	●	○	●	●	
Striped Dolphin	○	○	○		○	●	
Point Totals 12/	56	55	38	35	55	40	32

○ Not Significant = 1
◉ Significant = 2
● Very Significant = 3

(Significance relative to species distribution along the contiguous U.S. West Coast.)

Source: Strategic Assessment Branch (SAB). *West Coast of North America Coastal and Ocean Zones Strategic Assessment: Data Atlas, Marine Mammals Pre-publication Volume.*. NOAA, SAB, Rockville, MD.

FOOTNOTES:

1/ Mainly found in waters shallower than 20 m.
2/ Concentration of juveniles less than 3 years old and some adult females occur off the Washington Coast.
3/ No rookeries and only one minor haulout area occurs in Washington waters.
4/ Only males are found in Washington waters.
5/ Area 7 contains two out of the eight major rookeries located along the U.S. West Coast. Approx. 10,000 harbor seals are found in Washington
6/ Year-round Adult concentrations occur in Areas 6 and 7.
7/ Endangered.
8/ Areas important during seasonal migrations in Nov.-June.
9/ Nearly extinct in north Pacific (~200 animals).
10/ Feeding and migration areas occur off Washington.
11/ A major adult area occurs on the continental slope seaward of the study region during April-Sept.; additional individuals migrate through area in Sept. - Oct..
12/ A summary of point values (i.e. significance) associated with all species within an area.

APPENDIX A

Table A.1--Land use by county and USGS Cataloging Unit in lands adjacent to waters considered for the proposed coastal Washington marine sanctuary.

Study Area	County	Land use (in square miles)					
		Urban	Agriculture	Range	Forest	Wetlands	Totals
4	Clallam	29	35	11	1550	16	1641
4	Jefferson	22	9	17	1572	8	1627
4 & 7	Grays Harbor	34	58	6	1751	57	1906
7	Pacific	10	28	6	794	16	854
	Total	95	130	39	5666	97	6028

Study Area	Cataloging Unit	Land use (in square miles)					
		Urban	Agriculture	Range	Forest	Wetlands	Totals
4	17100101	9	4	9	1132	11	1165
4	17100102	6	0	1	1041	34	1082
7	17100104 (1)	15	37	1	780	9	843
7	17100105	11	4	2	430	18	466
7	17100106	11	27	6	869	17	929
	Total	42	68	10	3121	78	3320

(1) Land use information for Cataloging Unit 17100103 is not available.

Source: Strategic Assessment Branch. 1986. *West Coast Land Use Data for NCPDI Counties* [data base]. Rockville, MD: OMA/NOAA.

APPENDIX B

Appendix B. Freshwater Flow Information

Information on Freshwater Inputs into Areas Considered for the Proposed Coastal Washington Marine Sanctuary

Appendix Table B.1. lists the major rivers and streams in watersheds which drain into coastal portions of the sanctuary study region, along with the average long-term flow and the drainage area above the gage from which flow is measured. Of the 20 rivers and streams shown on Table B.1, the Chelhalis River, which discharges to Grays Harbor, has the largest flow. Compared to other major rivers on the West Coast, the rivers in this region are relatively small in terms of long term average flow. For example, the long-term flow of the Columbia River, measured at a point upstream of the confluence with the Williamette River, is about 40 times larger than that of the Chehalis River (192,000 cubic feet per second (cfs) versus 5,100 cfs).

While relatively small in terms of flow, the rivers adjacent to the study region have high water yields - the volume of river flow generated per unit area of land - compared to other rivers on the West Coast. For example, the Quinault River ranks first in water yield of the 47 rivers inventoried by NOAA in 1990, with a yield of 10.77 cfs per square mile, while the Columbia River ranks 40th on the West Coast, with a yield of 0.8 cfs per square mile. Water yield is a function of many factors, including precipitation, land use and topography of the river's watershed. In this case, the high yields for rivers in the study area primarily reflects substantial precipitation in the region and the relatively steep topography associated with mountainous terrain.

Source: Personal communication with Steve Rohmann, NOAA Strategic Assessment Branch, Rockville, MD.

Table B.1--Information on freshwater flow of rivers in lands adjacent to areas under consideration for the proposed coastal Washington marine sanctuary.

Study Area	River Name	Monitoring Station Location	Average daily flow (in cubic feet per second)	Drainage area at Gage (in square miles)	Ranking based on flow (1)	Yield (average flow/ drainage area)	Ranking based on yield (2)
4	Queets River	near Clearwater	4,227	445	14	9.50	4
4	Quinault River	at Quinault Lake	2,843	264	17	10.77	1
4	Hoh River	at Highway 101 near Forks	2,521	253	18	9.96	3
4	Soleduck River	near Quillayute	1,465	219	24	6.69	11
4	Bogachiel River	near Forks	955	111	28	8.60	5
4	Raft River	below Rainy Creek near Queets	543	76	32	7.14	8
4	Dickey River	near La Push	525	86	33	6.10	17
4	Ozette River	at Ozette	337	78	35	4.32	24
4	Moclips River	at Moclips	200	35	38	5.71	18
4	Sooes River	below Miller Creek near Ozette	198	32	40	6.19	16
7	Chehalis River	near Satsop	5,109	1,761	11	2.90	31
7	Humptulips River	near Humptulips	1,335	130	25	10.27	2
7	Wynoochee River	below Black Creek near Montesano	1,235	180	26	6.86	10
7	North River	near Raymond	963	219	27	4.40	23
7	Willapa River	near Willapa	628	130	29	4.83	21
7	Naselle River	near Naselle	425	55	34	7.73	6
7	Smith Creek	near Richmond	237	58	36	4.09	26
7	S. Fk., Naselle River	near Naselle	129	18	43	7.17	7
7	North Nemah River	near South Bend	115	18	44	6.39	13
7	Salmon Creek	near Naselle	112	16	45	7.00	9
	Total		24,102				

(1) Compares the average daily flow for 47 rivers discharging into the Pacific Ocean and Puget Sound. Included in the 47 rivers are the three with the largest average daily discharge: the Columbia River (192,734 cfs); the Willamette River (33,208 cfs); and the Sacramento River (25,217 cfs).

(2) Compares the yield for 47 rivers discharging into the Pacific Ocean and Puget Sound.

Source: Personal communication with Steve Rohmann. Strategic Assessment Branch, OMA/NOAA.

APPENDIX C

Appendix C. Pollution of Coastal Waters Information

Agricultural Pesticide Use in Lands Adjacent to Areas Considered for the Proposed Coastal Washington Marine Sanctuary

Lands adjacent to study Areas 4 and 7 contain relatively minor agricultural activity. The majority of these lands are forested (approximately 90%). The average agricultural acreage by county within these two study areas is only 3.6% (Appendix D Table D 1.3.). The major crops (excluding pasture/range) are alfalfa, barley, corn, wheat and peas. According to NOAA's National Coastal Pollutant Discharge Inventory, which maintains a data base of estimates on pesticide use for 28 common agricultural pesticides, the highest application by county for Areas 4 and 7 occurs in Grays Harbor County, with 6,836 pounds (base year 1982). In contrast, San Joaquin County, California is 98% agricultural area, with an estimated 658,000 pounds of the 28 agricultural pesticides applied. Typical of most pesticide application, herbicides make up the majority of amounts applied to lands adjacent to the proposed sanctuary region. Also, it should be noted that Clallum and Jefferson counties extend inland to Puget Sound; as a result, the total amount of agricultural pesticides applied in study Areas 4 and 7 is probably less than amounts estimated for those entire counties.

Additional Sources of Pesticides

Agricultural pesticide use in the Puget Sound and Columbia River Estuarine Drainage Areas (EDAs) is significantly higher than in drainage areas discharging to coastal waters of the proposed marine sanctuary. While it is possible that pesticides from the Columbia River and Puget Sound EDAs may affect the areas of the proposed sanctuary, it is unlikely because of travel times and amounts of dilution that occur in these systems.

Comparison of West Coast Pesticide Application Patterns by State

In comparison to the rest of the West Coast, Washington ranks second to California in agricultural pesticide application to coastal areas. More than three times as much pesticide was applied in coastal areas of California than in Washington. It should be noted, however, that California has significantly more coastal land area than Oregon and Washington combined.

Source: National Coastal Pollutant Discharge Inventory Program Data Base on Pesticide Use in Coastal Areas of the United States

Appendix Table C.1. Summary of pollutant discharges into counties adjacent to the proposed Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

Flow (millions of gallons per year)

USGS Cataloging Unit	Study Area	Point Sources: Wastewater Treatment Plants	Point Sources: Direct Industrial Dischargers	Nonpoint Sources: Urban Runoff	Nonpoint Sources: Cropland Runoff	Nonpoint Sources: Forestland Runoff	Nonpoint Sources: Pasture/ Range	Nonpoint Sources: Upstream Sources	All Sources: Total
17100101	4	40	7,630	567	0	798,700	6,666	0	813,603
17100102	4	97	4,232	0	0	599,100	582	0	604,011
17100103	7	8	11,800	173	2,440	12,220	1,649	824,000	852,289
17100104	7	417	27,480	11,800	14,350	315,600	12,470	0	382,117
17100105	7	2,403	17,530	7,154	4,390	219,800	1,260	0	252,537
17100106	7	636	6,033	100	3,782	212,700	5,973	0	229,224
Study Region Total:		3,602	74,705	19,794	24,962	2,158,120	28,600	824,000	3,133,781
West Coast Total:		971,400	702,000	862,500	750,200	8,858,000	1,352,000	94,850,000	112,500,000
% of West Coast:		0.4	10.6	2.3	3.3	24.4	2.1	0.9	2.8

BOD - Biochemical Oxygen Demand (tons per year)

USGS Cataloging Unit	Study Area	Point Sources: Wastewater Treatment Plants	Point Sources: Direct Industrial Dischargers	Nonpoint Sources: Urban Runoff	Nonpoint Sources: Cropland Runoff	Nonpoint Sources: Forestland Runoff	Nonpoint Sources: Pasture/ Range	Nonpoint Sources: Upstream Sources	All Sources: Total
17100101	4	5.1	153.0	28.4	0.0	8,061.1	9.4	0.0	8,257.0
17100102	4	12.9	84.8	0.0	0.0	4,152.1	0.8	0.0	4,250.6
17100103	7	1.1	1,648.0	10.9	93.3	116.3	4.8	5,160.0	7,034.8
17100104	7	63.5	4,068.2	589.0	28.4	5,187.4	11.2	0.0	9,947.7
17100105	7	89.8	2,384.0	459.0	0.3	3,526.0	1.2	0.0	6,460.3
17100106	7	114.0	482.3	50.3	256.6	7,058.5	21.5	0.0	7,983.3
Study Region Total:		286.3	8,820.3	1,137.6	379.1	28,101.5	48.8	5,160.0	43,933.7
West Coast Total:		339,670.0	54,580.0	46,748.0	58,652.0	232,630.0	163,840.0	620,180.0	1,516,300.0
% of West Coast:		0.1	16.2	2.4	0.6	12.1	0.0	0.8	2.9

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.1. Summary of pollutant discharges into counties adjacent to the proposed Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

TSS - Total Suspended Solids (tons per year)

		Point Sources		Nonpoint Sources					All Sources
USGS Cataloging Unit	Study Area	Wastewater Treatment Plants	Direct Industrial Dischargers	Urban Runoff	Cropland Runoff	Forestland Runoff	Pasture/ Range	Upstream Sources	Total
17100101	4	5.1	191.0	426.0	0.0	474,010.0	314.7	0.0	474,950.0
17100102	4	18.6	106.2	0.0	0.0	787,520.0	108.0	0.0	787,750.0
17100103	7	1.1	951.0	138.0	4,690.7	5,634.0	237.8	20,600.0	32,253.0
17100104	7	88.3	4,398.3	8,840.0	1,435.1	209,640.0	615.9	0.0	225,020.0
17100105	7	66.8	5,782.4	5,744.0	20.8	141,010.0	60.6	0.0	152,680.0
17100106	7	174.0	362.2	755.0	11,716.0	282,110.0	1,434.3	0.0	296,550.0
Study Region Total:		353.8	11,791.1	15,903.0	17,862.5	1,899,924.0	2,771.4	20,600.0	1,969,205.9
West Coast Total:		224,090.0	77,892.0	660,710.0	9,737,500	23,592,000	35,790,000	30,833,000	101,000,000
% of West Coast:		0.2	15.1	2.4	0.2	8.1	0.0	0.1	1.9

TN - Total Nitrogen (tons per year)

		Point Sources		Nonpoint Sources					All Sources
USGS Cataloging Unit	Study Area	Wastewater Treatment Plants	Direct Industrial Dischargers	Urban Runoff	Cropland Runoff	Forestland Runoff	Pasture/ Range	Upstream Sources	Total
17100101	4	1.9	22.3	6.5	0.0	4,023.5	4.7	0.0	4,058.9
17100102	4	4.6	12.4	0.0	0.0	2,075.8	0.4	0.0	2,093.2
17100103	7	0.5	116.7	2.1	73.1	58.2	2.4	2,890.0	3,143.0
17100104	7	22.9	104.2	136.0	29.1	2,593.6	5.6	0.0	2,891.4
17100105	7	113.5	65.5	89.1	3.6	1,763.1	0.6	0.0	2,035.4
17100106	7	37.1	31.4	11.6	139.6	3,524.0	10.8	0.0	3,754.5
Study Region Total:		180.4	352.5	245.4	245.4	14,038.3	24.4	2,890.0	17,976.3
West Coast Total:		55,648.0	3,605.1	10,167.0	39,110.0	116,300.0	81,931.0	330,520.0	644,520.0
% of West Coast:		0.3	9.8	2.4	0.6	12.1	0.0	0.9	2.8

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.1. Summary of pollutant discharges into counties adjacent to the proposed Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

TP - Total Phosphorus (tons per year)

		Point Sources		Nonpoint Sources					All Sources
USGS Cataloging Unit	Study Area	Wastewater Treatment Plants	Direct Industrial Dischargers	Urban Runoff	Cropland Runoff	Forestland Runoff	Pasture/ Range	Upstream Sources	Total
17100101	4	1.3	3.2	1.0	0.0	40.2	0.0	0.0	45.8
17100102	4	2.8	1.8	0.0	0.0	20.8	0.0	0.0	25.4
17100103	7	0.4	4.5	0.3	2.3	0.6	0.0	129.0	137.2
17100104	7	17.3	8.0	20.6	1.2	25.9	0.1	0.0	73.1
17100105	7	71.4	3.2	14.4	0.2	17.6	0.0	0.0	106.8
17100106	7	30.0	2.7	1.8	2.1	35.2	0.1	0.0	71.9
Study Region Total:		123.2	23.4	38.0	5.9	140.4	0.2	129.0	460.1
West Coast Total:		39,844.0	312.9	1,576.7	1,029.6	1,163.0	819.3	30,738.0	75,574.0
% of West Coast:		0.3	7.5	2.4	0.6	12.1	0.0	0.4	0.6

As - Arsenic (tons per year)

		Point Sources		Nonpoint Sources					All Sources
USGS Cataloging Unit	Study Area	Wastewater Treatment Plants	Direct Industrial Dischargers	Urban Runoff	Cropland Runoff	Forestland Runoff	Pasture/ Range	Upstream Sources	Total
17100101	4	0.0	0.0	0.0	0.0	3.1	0.0	0.0	3.1
17100102	4	0.0	0.0	0.0	0.0	5.1	0.0	0.0	5.1
17100103	7	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.5
17100104	7	0.1	0.0	0.3	0.0	1.4	0.0	0.0	1.8
17100105	7	0.3	0.0	0.2	0.0	0.9	0.0	0.0	1.5
17100106	7	0.1	0.0	0.0	0.1	1.8	0.0	0.0	2.0
Study Region Total:		0.5	0.0	0.6	0.1	12.4	0.0	3.4	17.0
West Coast Total:		91.7	24.1	24.2	77.7	114.5	221.8	630.7	1,184.6
% of West Coast:		0.5	0.1	2.4	0.1	10.8	0.0	0.5	1.4

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.1. Summary of pollutant discharges into counties adjacent to the proposed Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

Cd - Cadmium (tons per year)

USGS Cataloging Unit	Study Area	Point Sources: Wastewater Treatment Plants	Point Sources: Direct Industrial Dischargers	Nonpoint Sources: Urban Runoff	Nonpoint Sources: Cropland Runoff	Nonpoint Sources: Forestland Runoff	Nonpoint Sources: Pasture/ Range	Nonpoint Sources: Upstream Sources	All Sources: Total
17100101	4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2
17100102	4	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
17100103	7	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.4
17100104	7	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.2
17100105	7	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.4
17100106	7	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.2
Study Region Total:		0.3	0.1	0.2	0.0	0.8	0.0	3.4	4.8
West Coast Total:		72.9	8.2	7.3	3.9	9.4	14.3	431.7	547.7
% of West Coast:		0.4	1.6	2.4	0.2	8.0	0.0	0.8	0.9

Cr - Chromium (tons per year)

USGS Cataloging Unit	Study Area	Point Sources: Wastewater Treatment Plants	Point Sources: Direct Industrial Dischargers	Nonpoint Sources: Urban Runoff	Nonpoint Sources: Cropland Runoff	Nonpoint Sources: Forestland Runoff	Nonpoint Sources: Pasture/ Range	Nonpoint Sources: Upstream Sources	All Sources: Total
17100101	4	0.0	0.0	0.0	0.0	47.4	0.0	0.0	47.5
17100102	4	0.0	0.0	0.0	0.0	78.8	0.0	0.0	78.8
17100103	7	0.0	0.0	0.0	0.5	0.6	0.0	34.4	35.5
17100104	7	0.1	1.0	0.5	0.1	21.0	0.1	0.0	22.8
17100105	7	0.4	1.5	0.5	0.0	14.1	0.0	0.0	16.6
17100106	7	0.2	0.0	0.0	1.2	28.2	0.1	0.0	29.8
Study Region Total:		0.8	2.6	1.1	1.8	190.0	0.3	34.4	230.8
West Coast Total:		240.8	74.5	42.5	814.5	2,166.4	3,017.2	4,195.5	10,551.3
% of West Coast:		0.3	3.4	2.5	0.2	8.8	0.0	0.8	2.2

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.1. Summary of pollutant discharges into counties adjacent to the proposed Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

Pb - Lead (tons per year)

USGS Cataloging Unit	Study Area	Point Sources: Wastewater Treatment Plants	Point Sources: Direct Industrial Dischargers	Nonpoint Sources: Urban Runoff	Nonpoint Sources: Cropland Runoff	Nonpoint Sources: Forestland Runoff	Nonpoint Sources: Pasture/ Range	Nonpoint Sources: Upstream Sources	All Sources: Total
17100101	4	0.0	0.0	0.4	0.0	11.4	0.0	0.0	11.8
17100102	4	0.0	0.0	0.0	0.0	15.7	0.0	0.0	15.7
17100103	7	0.0	0.0	0.2	0.1	0.1	0.0	17.4	17.8
17100104	7	0.1	0.3	8.9	0.0	4.2	0.0	0.0	13.6
17100105	7	0.5	1.1	6.3	0.0	2.8	0.0	0.0	10.6
17100106	7	0.1	0.0	0.8	0.2	5.6	0.0	0.0	6.8
Study Region Total:		0.7	1.4	16.6	0.4	39.8	0.1	17.4	76.3
West Coast Total:		191.5	55.7	684.4	204.0	411.4	824.6	1,013.2	3,384.8
% of West Coast:		0.4	2.5	2.4	0.2	9.7	0.0	1.7	2.3

Hg - Mercury (pounds per year)

USGS Cataloging Unit	Study Area	Point Sources: Wastewater Treatment Plants	Point Sources: Direct Industrial Dischargers	Nonpoint Sources: Urban Runoff	Nonpoint Sources: Cropland Runoff	Nonpoint Sources: Forestland Runoff	Nonpoint Sources: Pasture/ Range	Nonpoint Sources: Upstream Sources	All Sources: Total
17100101	4	0.1	0.0	0.5	0.0	132.6	0.1	0.0	133.3
17100102	4	0.3	0.0	0.0	0.0	165.7	0.0	0.0	166.1
17100103	7	0.0	0.0	0.2	1.0	1.9	0.1	725.0	728.2
17100104	7	1.7	6.9	9.8	0.6	82.0	0.2	0.0	101.2
17100105	7	7.6	15.8	9.2	0.0	56.3	0.0	0.0	89.0
17100106	7	2.8	0.1	0.8	4.7	112.5	0.6	0.0	121.5
Study Region Total:		12.5	22.8	20.6	6.2	551.1	1.0	725.0	1,339.2
West Coast Total:		4,535.3	912.4	835.5	2,399.0	4,377.2	8,271.1	227,861.4	249,191.9
% of West Coast:		0.3	2.5	2.5	0.3	12.6	0.0	0.3	0.5

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.1. Summary of pollutant discharges into counties adjacent to the proposed Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

Oil and Grease (tons per year)

		Point Sources		Nonpoint Sources					All Sources
USGS Cataloging Unit	Study Area	Wastewater Treatment Plants	Direct Industrial Dischargers	Urban Runoff	Cropland Runoff	Forestland Runoff	Pasture/ Range	Upstream Sources	Total
17100101	4	2.6	0.0	16.9	0.0	0.0	0.0	0.0	19.5
17100102	4	4.6	0.0	0.0	0.0	0.0	0.0	0.0	4.6
17100103	7	1.0	0.0	5.2	0.0	0.0	0.0	0.0	6.1
17100104	7	33.6	2.4	191.0	0.0	0.0	0.0	0.0	227.0
17100105	7	116.5	0.6	159.4	0.0	0.0	0.0	0.0	276.4
17100106	7	60.9	0.7	15.4	0.0	0.0	0.0	0.0	77.0
Study Region Total:		219.1	3.6	387.9	0.0	0.0	0.0	0.0	610.6
West Coast Total:		62,561.5	1,652.2	29,581.3	0.0	0.0	0.0	0.0	93,795.1
% of West Coast:		0.4	0.2	1.3	N/A	N/A	N/A	N/A	0.7

Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.2--Major point source dischargers into counties adjacent to areas under consideration for the proposed coastal Washington marine sanctuary (circa 1984).

Study Area	USGS Cataloging Unit	NPDES Code	Facility Name	SIC Code	Activity	Flow - in millions of gallons/year
7	17100103	WA0039144	Domsea Farms	2091	Canned and cured seafoods	900.0
7	17100104	WA0000809	Weyerhaeuser Co., Cosmopolis	2611	Pulp mills	8,220.0
7	17100105	WA0003077	ITT Rayonier Inc., Hoquiam	2611	Pulp mills	9,760.0
7	17100105	WA0037192	Aberdeen Sewage Treatment Plant	4952	Sewerage systems	1,680.0
7	17100105	WA0020915	Hoquiam Sewage Treatment Plant	4952	Sewerage systems	617.0
7	17100106	WA0024848	Peterson and Sons Seafood, Inc.	2091	Canned and cured seafoods	110.0
7	17100106	WA0001988	Harbor Bell, Inc.	2092	Fresh and frozen packaged fish	43.6
Total						21,330.6

Notes: NPDES - National Pollutant Discharge Elimination System; SIC - Standard Industrial Classification
Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix C.3--Description of pollutant outputs by major point sources discharging into counties adjacent to areas under consideration for the proposed coastal Washingtor marine sanctuary (circa 1984).

Facility Name	BOD tons/year	TSS tons/year	TN tons/year	TP tons/year	Arsenic tons/year	Cadmium tons/year	Chromium tons/year	Lead tons/year	Mercury pounds/year	Oil & Grease tons/year
Domsea Farms	1,430	679	85	0	0	0	0	0	0	0
Weyerhaeuser Co., Cosmopolis	3,680	3,910	48	0	0	0	1.03	0.343	6.86	0
ITT Rayonier Inc., Hoquiam	2,140	5,520	39	0	0.0257	0.128	1.48	1.05	15.8	0
Aberdeen Sewage Treatment Plant	60	30	79	49	0.226	0.0792	0.301	0.313	5.23	79
Hoquiam Sewage Treatment Plant	11	15	29	18	0.0831	0.0291	0.11	0.115	1.92	29
Peterson and Sons Seafood, Inc.	255	155	9	0	0.000157	0.000784	0.00392	0.0047	0.0627	0
Harbor Bell, Inc.	76	39	4	0	0	0	0	0	0	0
Totals	7,651	10,348	292	67	0	0	3	2	30	108

Notes: BOD - Biochemical Oxygen Demand; TSS - Total Suspended Solids; TN - Total Nitrogen; TP - Total Phosphorus
Source: Strategic Assessment Branch, NOAA, 1984: The National Coastal Pollutant Discharge Inventory, Rockville, MD

Appendix Table C.4--Number of direct discharging point sources within counties adjacent to areas under consideration for the proposed coastal Washington marine sanctuary, by USGS Cataloging Unit and source category (circa 1984).

USGS Cataloging Unit	Study Area	Industrial			Waste Water Treatment Plants			Total		
		Major	Minor	Total	Major	Minor	Total	Major	Minor	Total
17100101	4	0	2	2	0	2	2	0	4	4
17100102	4	0	2	2	0	2	2	0	4	4
17100103	7	1	5	6	0	1	1	1	6	7
17100104	7	1	9	10	0	3	3	1	12	13
17100105	7	1	17	18	2	2	4	3	19	22
17100106	7	2	16	18	0	4	4	2	20	22
Totals		5	51	56	2	14	16	7	65	72

Note: The qualifiers "Major" and "Minor" are from EPA'a classification for discharging facilities.

APPENDIX D

Table D.1--Socio-economic information for coastal counties associated with the proposed coastal Washington marine sanctuary and other coastal regions of the USA: Demographics.

Region	Population by age group (1980)					Total population by year							Population Density
	Under 5	5-17	Under 18	18-64	Over 65	1960	1970	1980	1988	1990	2000	2010	1988
Outer Washington Coast													
Clallam County	4,009	9,957	13,966	30,370	7,312	30,022	34,770	51,648	56,000	58,802	67,801	73,577	32
Grays Harbor County	5,252	13,716	18,968	38,950	8,396	54,465	59,553	66,314	62,900	64,011	67,463	70,953	33
Jefferson County	1,071	2,907	3,978	9,469	2,518	9,639	10,661	15,965	19,500	21,048	25,490	28,150	11
Pacific County	1,188	3,221	4,409	9,860	2,968	14,674	15,796	17,237	17,800	17,937	19,138	20,216	20
Counties combined	11,520	29,801	41,321	88,649	21,194	108,800	120,780	151,164	156,200	161,798	179,892	192,896	24
County average	2,880	7,450	10,330	22,162	5,299	27,200	30,195	37,791	39,050	40,450	44,973	48,224	24
State of Washington													
Coastal counties combined	306,123	833,237	1,139,360	2,561,234	431,562	2,853,000	3,413,000	4,132,000	4,648,000	4,733,000	5,235,000	5,593,000	70
County average	7,849	21,365	29,214	65,673	11,066	73,154	87,513	105,949	119,179	121,359	134,231	143,410	70
West Coast (1)													
Coastal counties combined	1,681,325	4,639,395	6,320,720	15,112,452	2,401,728	16,171,992	20,485,022	23,835,249	27,574,600	28,250,430	31,288,949	33,497,063	351
County average	32,333	89,219	121,552	290,624	46,187	311,000	393,943	458,370	530,281	543,278	601,711	644,174	351
Total Coastal USA (2)													
Coastal counties combined	6,919,389	20,505,029	27,424,418	62,016,017	11,407,738	79,757,829	92,941,938	100,849,575	110,181,700	111,643,081	120,005,141	127,226,234	157
County average	15,342	45,466	60,808	137,508	25,294	176,847	206,080	223,613	244,305	247,546	266,087	282,098	157

(1) Washington, Oregon, and California.
(2) Includes Alaska, Hawaii, and the Great Lakes region.

Sources: Bureau of the Census. 1989. Current Populations Reports, Population Estimates and Projections. Series p-26, No. 88-a. County Population Estimates: July 1, 1988, 1987, and 1986. U.S. Department of Commerce. Washington, D.C.: U.S. Government Printing Office. 45 pp.
National Planning Association Data Services, Inc. 1988. *Key Indicators of County Growth, 1970-2010* [data base]. Washington, D.C.: National Planning Association Data Services, Inc.
Slater Hall Information Products, Inc. 1988. *Populations Statistics* [data base]. Washington, D.C.: Slater Hall Information Products, Inc.

Table D.2--Socio-economic information for coastal counties associated with the proposed coastal Washington marine sanctuary and other coastal regions of the USA: Single unit housing construction permits and levels of occupancy.

Region	Numbers of Construction Permits for Single Housing Units by Year					Total Housing Units	Total Units Occupied	Total Year-round Detached Housing (3)	Aggregate Value in Dollars (4)
	1985	1986	1987	1988	1989	(1980)	(1980)	(1980)	(1980)
Outer Washington Coast									
Clallam County	178	230	195	283	414	21,851	19,996	14,908	2,479,525
Grays Harbor County	100	95	90	108	118	28,598	25,181	18,912	2,509,515
Jefferson County	128	125	127	137	255	8,826	6,359	5,740	849,725
Pacific County	48	58	50	46	56	10,949	6,940	5,810	616,010
Counties combined	454	508	462	574	843	70,224	58,476	45,370	6,454,775
County average	114	127	116	144	211	17,556	14,619	11,343	1,613,694
State of Washington									
Coastal counties combined	17,041	19,262	19,962	21,484	26,420	1,689,450	1,540,510	1,145,385	80,183,508
County average	437	494	512	551	677	43,319	39,500	67,376	2,055,987
West Coast (1)									
Coastal counties combined	91,908	107,543	103,089	114,925	121,473	9,347,412	8,807,322	5,292,796	1,554,550,670
County average	1,767	2,068	1,982	2,210	2,336	179,758	169,372	101,785	29,895,205
Total Coastal USA (2)									
Coastal counties combined	430,989	479,222	465,496	448,062	420,071	39,598,628	36,236,919	20,103,017	4,409,191,540
County average	956	1,063	1,032	993	931	87,802	80,348	44,574	9,776,478

(1) Washington, Oregon, and California.
(2) Includes Alaska, Hawaii, and the Great Lakes region.
(3) Total year-round, detached, single family housing units (includes owner-occupied and rentals).
(4) Aggregation for all non-condominium dwellings (owner-occupied only). Value should be multiplied by 250.

Sources: Bureau of the Census. 1988. *County and City Data Book, 1988.* U. S. Department of Commerce. Washington, D. C.: U. S. Government Printing Office. 797 pp. + Appendices.
Bureau of the Census. 1990. *Building Permit Data Offering Information Package* [data base]. Prepared by the Construction Statistics Division, Building Permits Branch. Washington, D.C. U.S. Department of Commerce.
Slater Hall Information Products, Inc. 1988. *Populations Statistics* [data base]. Washington, D.C.: Slater Hall Information Products, Inc.

Table D.3--Socio-economic information for coastal counties associated with the proposed coastal Washington marine sanctuary and other coastal regions of the USA: Employment and farming information.

Region	Employment							Farming (1982)		Total Land Area (1980)
	Numbers per sector (1985)					Total work force 1986	Total unemployed 1986	Farm acreage (x 1000)	Value of farm report ($ x 1kk)	(sq. mi.)
	Manufacturing	Retail	FIRE (3)	Service	Total non-farm					
Outer Washington Coast										
Clallam County	2,785	3,010	454	2,292	10,660	21,956	2,161	28	6	1,753
Grays Harbor County	5,782	3,735	598	3,305	16,066	25,910	3,272	49	17	1,918
Jefferson County	644	943	117	700	2,876	7,776	638	16	3	1,805
Pacific County	989	827	155	772	3,441	6,968	870	39	9	908
Counties combined	10,200	8,515	1,324	7,069	33,043	62,610	6,941	132	35	6,384
County average	2,550	2,129	331	1,767	8,261	15,653	1,735	33	9	1,596
State of Washington										
Coastal counties combined	280,329	300,816	100,123	361,519	1,336,675	2,178,000	179,000	16,470	2,831	66,511
County average	7,188	7,713	2,567	9,270	34,274	55,846	4,590	422	73	1,705
West Coast (1)										
Coastal counties combined	2,265,532	1,945,214	807,037	2,737,134	9,803,060	13,454,362	846,407	12,921	4,843	78,502
County average	43,568	37,408	15,520	52,637	188,520	258,738	16,277	248	93	1,510
Total Coastal USA (2)										
Coastal counties combined	8,449,476	7,819,010	3,250,097	11,287,437	38,927,505	53,121,270	3,470243	62,471	16,987	701,894
County average	18,735	17,337	7,206	25,028	86,314	117,786	7,695	139	38	1,556

(1) Washington, Oregon, and California.
(2) Includes Alaska, Hawaii, and the Great Lakes region.
(3) Finance, Insurance, and Real Estate.

Source: Bureau of the Census. 1988. *County and City Data Book, 1988.* U. S. Department of Commerce. Washington, D. C.: U. S. Government Printing Office. 797 pp. + Appendices.

APPENDIX E

Appendix E. Living Marine Resources Information

Methodology for the Comparative Significance of Study Areas analyses

The relative importance of the seven analysis areas within the marine sanctuary study region was determined by examining information concerning distribution and abundance of the region's living marine resources. The assumption of this examination was that an area which was important at the highest level of significance for the greatest number of species would be more valuable as a marine sanctuary than other study areas. This was tested by evaluating the "significance" of each study area based on geographical distributions for any life stage of a variety of species. The species selected for this analysis were those addressed in the *West Coast of North America Coastal and Ocean Zones Strategic Assessment: Data Atlas*, a NOAA publication. They included 19 species of invertebrates, 33 fishes, 22 marine birds, and 24 marine mammals. The following is a list of factors relating to this analysis.

- Each group of species (i.e., invertebrates, fishes, etc.) was treated separately, but examined similarly.
- The criterion for the analysis was the extent that the species used the study area (i.e., how much of a species' distribution covered the area) and the relative level of abundance of the species as shown in the atlas (e.g., occasional occurrence, adult area, major adult area, etc.).
- Scores were given to each area for every species as follows:
  --"3" for *very significant presence*. For this rating, at least one-quarter of the study area contained the highest level of abundance present off the contiguous U.S. West Coast (for any life stage), and most of the remaining portion of the study area contained other levels of abundance.
  --"2" for *significant presence*. This rating was given when at least half of the study area contained the at least the lowest level of abundance present off the West Coast.
  --"1" for *present, but not significantly*. This rating was given when less than half of the study area contained the lowest level of abundance present off the West Coast.
  --"0" for not present.
- A two-person team analyzed each group.
- No judgements were made regarding the importance of the species.
- After the team examined its group, the two team members compared their independent evaluations and reconciled scoring differences.

The relative significance of each area was then determined by summing the scores for all species in the group: the higher the cumulative total, the more important the area.

The above described analysis attempted to objectively examine qualitative information to derive the relative importance of one study area to another. However, the analysis was somewhat biased toward species with wide geographic distributions. For example, market squid pelagically occurs along most of the West Coast from coastal waters to far offshore, while Pacific razor clam is found only along sandy beaches at very restricted depths. Area 7, a shallow-water nearshore area, was scored identically for the two species, even though high concentrations of the razor clam occur in this area. The identical moderate score ("2") resulted because the razor clam concentrations occur only in a narrow band that was smaller than that identified for the highest rating ("3").

Because of possibly low rankings of limited-distribution species, a second analysis was performed on invertebrates and fishes. This analysis incorporated a "density index" into scoring species importance for each study area. Since all species examined have recreational and/or commercial importance, the density index was based on commercial and sport catch statistics for harvests in

Appendix E.
Methodology...(continued).

the study region. The index ranged from 10 to 1, depending upon harvest levels. For example, a heavily harvested species like Dungeness crab was assigned an index value of "10", the moderately harvested giant octopus was assigned an index value of "4", and the slightly harvested spot shrimp was assigned a value of "2". The study area score from the previous analysis was then multiplied by the density index and resulted in the following scores:

- --21 to 30. This score was given to an area when it contained a widely distributed and highly abundant species.
- --11 to 20. This score was assigned when the area contained a species that was either widely distributed or highly abundant.
- --l0 or less. This score was assigned when the area contained a species that only occasionally occurred there and not abundantly.

An area's relative importance was then determined by summing that area's scores for all species and comparing the totals for each area.

Table E.1--Estimated volumes (lbs) landed for commerical harvests from along Washington's outer coast and from all Washington waters, 1987 and 1988.

	Washington's outer coast (1)			Washington in-state total (2)		
Species (3)	1987	1988	Average	1987	1988	Average
albacore	183,986	2,456,513	1,320,250	183,986	2,456,513	1,320,250
northern anchovy	171,111	78,864	124,988	171,111	78,957	125,034
Pacific herring	0	0	0	1,190,921	1,756,510	1,473,716
silver smelt	75,330	64,762	70,046	135,132	150,846	142,989
Pacific halibut	322,121	267,218	294,670	346,948	286,047	316,498
butter sole	60	0	30	1,478	3,266	2,372
Dover sole	3,239,532	4,229,425	3,734,479	3,288,115	4,278,631	3,783,373
English sole	1,002,043	835,678	918,861	1,813,727	1,835,938	1,824,833
petrale sole	999,804	836,134	917,969	1,000,044	836,276	918,160
rex sole	130,157	93,849	112,003	130,639	93,849	112,244
rock sole	5,837	7,223	6,530	74,810	63,771	69,291
sand sole	197,417	50,852	124,135	255,100	141,008	198,054
sole spp.	13,854	12,550	13,202	13,884	12,550	13,217
sanddab	12,870	5,169	9,020	13,013	5,169	9,091
starry flounder	111,114	259,570	185,342	612,439	818,031	715,235
arrowtooth flounder	4,315,506	2,654,272	3,484,889	4,324,834	2,660,171	3,492,503
sablefish	6,219,161	6,034,711	6,126,936	6,257,003	6,105,933	6,181,468
lingcod	2,211,308	1,589,194	1,900,251	2,332,417	1,682,270	2,007,344
Pacific cod	3,273,366	4,773,738	4,023,552	5,029,319	5,971,136	5,500,228
walleye pollock	58,289	47,048	52,669	134,812	69,023	101,918
Pacific whiting	5,700	35,397	20,549	672,588	616,217	644,403
Pacific ocean perch	979,545	1,190,554	1,085,050	979,890	1,190,554	1,085,222
idiot rockfish		64,003	32,002	7,069,021	64,057	3,566,539
widow rockfish		5,223,678	2,611,839	3,694,795	5,223,820	4,459,308
yellowtail rockfish		4,846,618	2,423,309	0	4,917,578	2,458,789
rockfish spp	16,190,859	3,910,067	10,050,463	5,557,830	3,912,644	4,735,237
rockfish oth.		2,544,913	1,272,457	0	2,662,550	1,331,275
striped seaperch	0	0	0	18,178	18,253	18,216
pile perch	98	232	165	79,137	99,671	89,404
silver perch	128	12	70	128	12	70
sculpins spp.	1,964	2,441	2,203	4,629	4,888	4,759
sharks spp.	2,173	2,761	2,467	5,075	4,213	4,644
blue shark	497	123	310	497	123	310
spiny dogfish	301,176	431,075	366,126	3,456,157	3,520,486	3,488,322
soupfin shark	3,332	2,410	2,871	3,593	2,410	3,002
thresher shark	60,144	1,792	30,968	60,144	1,792	30,968
skates	103,732	55,180	79,456	336,133	279,953	308,043
chinook salmon	2,616,986	2,570,789	2,593,888	8,016,318	8,893,032	8,454,675
chum salmon	1,307,989	2,055,501	1,681,745	13,953,578	17,994,381	15,973,980
pink salmon	93,401	234	46,818	9,611,376	1,076	4,806,226
coho salmon	2,277,399	8,180,325	5,228,862	12,722,433	8,247,784	10,485,109
sockeye salmon	100,993	103,083	102,038	11,930,998	5,310,045	8,620,522
butter clam	0	0	0	15,315	8,561	11,938
cockles	0	0	0	1,657	2,450	2,054
horse clams	0	0	0	21,648	6,575	14,112
geoduc	0	0	0	4,462,055	4,608,828	4,535,442
Pacific littleneck	13,977	206	7,092	1,253,165	960,082	1,106,624
razor clam	103	94	99	103	94	99
Manila clam	119,003	80,134	99,569	3,888,210	3,124,197	3,506,204
softshell clams	0	6,031	3,016	344,210	135,645	239,928

Table E.1--Estimated volumes (lbs) landed ... (continued)

Species (3)	Washington's outer coast (1)			Washington in-state total (2)		
	1987	1988	Average	1987	1988	Average
blue mussel	0	0	0	284,039	248,861	266,450
California mussel	0	0	0	645	0	323
mussels spp.	75	0	38	12,885	0	6,443
Olympia oyster	0	0	0	7,125	38,464	22,795
Pacific oyster	6,374,513	5,437,602	5,906,058	9,436,221	7,777,552	8,606,887
Kumamoto oyster	0	0	0	312	89	201
European oyster	0	0	0	9,030	8,385	8,708
Dungeness crab	5,067,139	14,546,162	9,806,651	6,720,516	16,480,027	11,600,272
coonstripe shrimp	0	20	10	50,598	98,420	74,509
spot shrimp	0	0	0	34,214	65,861	50,038
sidestripe shrimp	0	0	0	1,002	856	929
ocean pink shrimp	12,168,800	14,690,461	13,429,631	12,202,834	14,715,282	13,459,058
scallops	0	0	0	39,163	46,682	42,923
octopus	38,237	47,210	42,724	85,041	131,096	108,069
squid	1,669	519	1,094	8,720	3,280	6,000
sea cucumbers	0	0	0	365,081	2,100,114	1,232,598
red sea urchin	0	7,030	3,515	3,602,986	8,846,945	6,224,966
green sea urchin	0	0	0	300,258	1,010,090	655,174
Totals	70,374,485	90,335,415	80,352,963	148,631,250	152,691,858	150,659,567

Notes:

(1) Cape Flattery to Cape Disappointment; landings for anadromous species include harvests from coastal rivers.

(2) Includes outer coastal waters, the Strait of Juan De Fuca, Puget Sound, and Washington rivers (landings for Columbia River tributaries are incorporated).

(3) Estimates are based on 1987 and 1988 pounds landed by State of Washington statistical subarea provided by Dale Ward, Washington Department of Fisheries, Olympia, WA.

Table E.2--Estimated values (dollars) for commercial landings from harvests along Washington's outer coast and from all Washington waters, 1987 and 1988.

Species (3)	Washington's outer coast (1)			Washington in-state total (2)		
	1987	1988	Average	1987	1988	Average
albacore	132,249	2,048,977	1,090,613	132,249	2,048,977	1,090,613
northern anchovy	58,742	29,945	44,344	58,742	29,980	44,361
Pacific herring	0	0	0	479,346	1,085,348	782,347
silver smelt	8,814	22,304	15,559	15,810	51,951	33,881
Pacific halibut	464,273	328,892	396,582	500,056	352,067	426,061
butter sole	25	0	12	611	1,225	918
Dover sole	827,053	1,079,772	953,412	839,456	1,092,334	965,895
English sole	296,304	247,110	271,707	536,319	542,887	539,603
petrale sole	747,653	625,261	686,457	747,833	625,367	686,600
rex sole	39,112	28,202	33,657	39,257	28,202	33,729
rock sole	2,185	3,021	2,603	28,001	26,669	27,335
sand sole	121,017	31,172	76,094	156,376	86,438	121,407
sole spp.	5,729	4,482	5,105	5,741	4,482	5,111
sanddab	4,129	1,658	2,893	4,175	1,658	2,916
starry flounder	28,323	66,164	47,244	156,111	208,516	182,313
arrowtooth flounder	630,064	361,246	495,655	631,426	362,049	496,738
sablefish	4,215,347	4,608,105	4,411,726	4,240,997	4,662,490	4,451,744
lingcod	773,294	500,278	636,786	815,646	529,579	672,612
Pacific cod	1,063,189	1,281,749	1,172,469	1,633,523	1,603,250	1,618,386
walleye pollock	10,271	3,359	6,815	23,754	4,928	14,341
Pacific whiting	305	1,734	1,020	35,983	30,195	33,089
Pacific ocean perch	310,026	340,975	325,500	310,135	340,975	325,555
idiot rockfish	2,255,018	18,452	1,136,735	2,255,018	18,468	1,136,743
widow rockfish	1,166,853	1,505,986	1,336,420	1,166,853	1,506,027	1,336,440
yellowtail rockfish	0	1,397,280	698,640	0	1,417,738	708,869
rockfish spp	5,164,884	1,127,272	3,146,078	5,206,605	1,128,015	3,167,310
rockfish oth.	0	733,698	366,849	0	767,613	383,807
striped seaperch	0	0	0	0	0	0
pile perch	0	0	0	0	0	0
silver perch	0	0	0	0	0	0
sculpins spp.	689	488	589	1,625	978	1,301
sharks spp.	3,101	3,778	3,440	7,243	5,765	6,504
blue shark	709	168	439	709	168	439
spiny dogfish	40,599	63,152	51,876	465,890	515,751	490,821
soupfin shark	4,755	3,298	4,027	5,128	3,298	4,213
thresher shark	85,838	2,452	44,145	85,838	2,452	44,145
skates	5,830	3,316	4,573	18,891	16,825	17,858
chinook salmon	4,494,673	2,570,789	3,532,731	13,768,026	8,893,032	11,330,529
chum salmon	1,558,992	2,295,173	1,927,083	16,631,270	20,292,526	18,461,898
pink salmon	46,122	115	23,119	4,746,097	531	2,373,314
coho salmon	4,228,649	1,850,299	3,039,474	23,623,014	18,655,221	21,139,118
sockeye salmon	183,151	379,445	281,298	21,636,865	19,550,321	20,593,593
butter clam	0	0	0	12,760	7,133	9,947
cockles	0	0	0	1,381	2,041	1,711
horse clams	0	0	0	18,037	5,478	11,758
geoduc	0	0	0	2,900,336	2,995,738	2,948,037
Pacific littleneck	11,646	172	5,909	1,044,137	799,940	922,039
razor clam	128	117	122	128	117	122

Table E.2--Estimated values (dollars) for commercial landings ... (continued)

Species (3)	Washington's outer coast (1)			Washington in-state total (2)		
	1987	1988	Average	1987	1988	Average
Manila clam	99,153	66,768	82,960	3,239,657	2,603,081	2,921,369
softshell clams	0	5,025	2,513	286,796	113,019	199,908
blue mussel	0	0	0	333,774	292,437	313,105
California mussel	0	0	0	758	0	379
mussels spp.	88	0	44	15,141	0	7,571
Olympia oyster	0	0	0	169,982	917,639	543,811
Pacific oyster	8,117,305	6,924,242	7,520,774	12,016,084	9,903,935	10,960,009
Kumamoto oyster	0	0	0	3,245	926	2,085
European oyster	0	0	0	93,912	87,204	90,558
Dungeness crab	6,866,480	16,032,780	11,449,630	9,106,971	18,164,286	13,635,628
coonstripe shrimp	0	8	4	34,204	41,238	37,721
spot shrimp	0	0	0	23,129	27,596	25,362
sidestripe shrimp	0	0	0	677	359	518
ocean pink shrimp	8,226,109	6,155,303	7,190,706	8,249,116	6,165,703	7,207,409
scallops	0	0	0	45,394	54,109	49,751
octopus	18,113	22,363	20,238	40,284	62,100	51,192
market squid	697	173	435	3,644	1,093	2,369
sea cucumbers	0	0	0	64,035	368,360	216,198
red sea urchin	0	0	0	926,688	10,571,215	5,748,951
green sea urchin	0	0	0	77,226	1,206,957	642,091
Totals	52,319,672	52,778,510	52,547,103	139,720,101	140,887,988	140,302,057

Notes:

(1) Cape Flattery to Cape Disappointment; landings for anadromous species include harvests from coastal rivers.

(2) Includes outer coastal waters, the Strait of Juan De Fuca, Puget Sound, and Washington rivers (landings for Columbia River tributaries are incorporated).

(3) Estimates are based on 1987 and 1988 pounds landed by State of Washington statistical subarea and extrapolations of average prices per pound provided by John Bishop, Fisheries Development Div., NMFS, NW Regional Office, Seattle

REFERENCES

Sources for Information used in this report:

Bureau of the Census. 1988. *County and city data book, 1988.* U.S. Department of Commerce. Washington, D.C.: U.S. Government Printing Office. 797 pp. + appendices.

Bureau of the Census. 1989. Current population reports, population estimates, and projections. Series p-26, No. 88-a. County population estimates: July 1, 1988, 1987, and 1986. U.S. Department of Commerce. Washington, D.C.: U.S. Government Printing Office. 45 pp.

Bureau of the Census. 1990. *Building permit data ordering information package* [data base]. Prepared by the Construction Statistics Division, Building Permit Branch. U.S. Department of Commerce. Washington, D.C.

Carter, E. R., D. L. Jaques, C. S. Strong, G. J. McChesney, M. W. Parker, and J. E. Takekawa. In prep. Survey of seabird colonies in northern and central California. U.S. Fish and Wildl. Serv., Dixon, CA.

Culliton, T.J., M. A. Warren, T. R. Goodspeed, D. G. Remer, C. M. Blackwell, and J. J. McDonough, III. 1990. *Fifty years of population change along the Nation's coasts, 1960-2010. Coastal trends series, report #2.* NOAA, Natl. Ocean Serv., Strategic Assessment Branch, 6001 Executive Blvd., Suite 220, Rockville, MD. 41 pp.

Leonard, D. L. and D. A. Slaughter. 1990. *The quality of shellfish growing waters on the West Coast of the United States.* NOAA, Natl. Ocean Serv., Strategic Assessment Branch, 6001 Executive Blvd., Suite 220, Rockville, MD. 52 pp.

Massey, B.W. 1988. California least tern field study, 1988 breeding season. Cal. Dept. Fish and Game Contract FG 7660, Cal. State Univ., Long Beach, CA.

National Planning Association and Data Services, Inc. 1988. *Key indicators of county growth, 1970-2010* [data base]. Washington, D.C.: National Planning Association Data Services, Inc.

NMFS (National Marine Fisheries Service). 1989a. State of Washington volumes and values for fish and shellfish landed in the state of Washington during 1988. Computer printout compiled and provided by the NMFS Northwest Region Headquarters, Fisheries Statistics Section, 7600 Sand Point Way NE., Seattle, WA.

NMFS. 1989b. Fisheries of the United States 1988. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Current Fisheries Statistics No. 8800. 116 pp.

NMFS. 1990. State of Washington volumes and values for fish and shellfish landed in the state of Washington during 1989. Computer printout compiled and provided by the NMFS Northwest Region Headquarters, Fisheries Statistics Section, 7600 Sand Point Way NE., Seattle, WA.

PacFIN (Pacific Fisheries Information Network). 1989. PFMC (Pacific Fisheries Management Council) source report #002: Commercial groundfish land catch (metric tons) for 1981-88, all areas. Pacific States Marine Fisheries Commission, Groundfish Reports, PacFIN, 7600 Sand Point Way NE., Seattle, WA. Will Daspit, system manager.

PMFC (Pacific Marine Fisheries Commission). 1986. Thirty-eighth (38th) annual report of the Pacific Marine Fisheries Commission for the year 1985. R. G. Porter (editor). PMFC, 2000 SW First Ave., Suite 170, Portland, OR. 36 pp.

PMFC. 1987. Thirty-ninth (39th) annual report of the Pacific Marine Fisheries Commission for the year 1986. R. G. Porter (editor). PMFC, 2000 SW First Ave., Suite 170, Portland, OR. 29 pp.

PMFC. 1988. Fortieth (40th) annual report of the Pacific Marine Fisheries Commission for the year 1987. R. G. Porter (editor). PMFC, 2000 SW First Ave., Suite 170, Portland, OR. 25 pp.

PMFC. 1989. Forty-first (41st) annual report of the Pacific Marine Fisheries Commission for the year 1988. R. G. Porter (editor). PMFC, 2000 SW First Ave., Suite 170, Portland, OR. 22 pp.

SAB (Strategic Assessment Branch). 1984. *Inventory of public outdoor recreation areas and facilities.* NOAA, Natl. Ocean Serv., Strategic Assessment Branch, 6001 Executive Blvd., Suite 220, Rockville, MD.

SAB. 1985. *National estuarine inventory: Data Atlas, volume 1: Physical and hydrologic characteristics.* NOAA, NOS, SAB, 6001 Executive Blvd., Suite 220, Rockville, MD. 103 pp.

SAB. 1986. West coast land use data for NCPDI counties [data base]. NOAA, NOS, SAB, 6001 Executive Blvd., Suite 220, Rockville, MD.

SAB. 1988. *West coast of North America coastal and ocean zones strategic assessment: Data atlas, marine mammal prepublication volume.* NOAA, NOS, SAB,6001 Executive Blvd., Suite 220, Rockville, MD. 33 pp.

SAB. 1990. Cmas (Computer Mapping and Analysis System) analysis of seabird colonies for the west coast of North America. NOAA, NOS, SAB, 6001 Executive Blvd., Suite 220, Rockville, MD.

SAB. in press. West coast of North America coastal and ocean zones strategic assessment: Data atlas, invertebrate and fish prepublication volume (scheduled for publication in November, 1990). NOAA, NOS, SAB, 6001 Executive Blvd., Suite 220, Rockville, MD.

Schink, T.J., K. A. McGraw, and K. K. Chew. 1983. *Pacific coast clam fisheries.* Washington State Sea Grant Tech. Rep. 83-1. Univ. of Washington, Seattle, WA. 72 pp.

Slater Hall Information Products, Inc. 1988. *Population statistics* [data base]. Washington, D.C.: Slater Hall Information Products, Inc.

Sowls, A. L., A. R. DeGange, J. W. Nelson, and G. S. Lester. 1980. *Catalog of California seabird colonies.* U.S. Fish and Wildl. Serv., Biol. Serv. Program. FWS/OBS 80/37.

Speich, S. M. and T. R. Wahl. 1989. *Catalog of Washington seabird colonies.* U.S. Fish and Wildl. Serv., Biological Rpt. 88(6).

WDF (Washington Department of Fisheries). 1983. 1982 Fisheries statistical report for the state of Washington. Compiled and edited by W. D. Ward and L. J. Hoines. Wash. Dept. Fish., Olympia, WA. 77 pp.

WDF. 1987. 1986 Fisheries statistical report for the state of Washington. Compiled and edited by W. D. Ward and L. J. Hoines. Wash. Dept. Fish., Olympia, WA. 89 pp.

WDF. 1989. Commercial catches for fish and shellfish species by statistical subarea and month for the State of Washington, 1987 and 1988. Computer printout provided by D. Ward, Wash. Dept. Fish., Olympia, WA.

Personal communication on razor clams from Doug Simons, Washington Dept. of Fisheries, Montasano, WA.

Personal communication on razor clam harvests from Terry Link, Oregon Dept. of Fisheries and Wildlife, Astoria, OR.

Personal communication on Oregon seabirds from Roy Lowe, West Oregon Refuge Complex, U.S. Fish and Wildlife Service, Newport, Oregon.

Personal communications on freshwater flow and discharge from Steve Rohmann, Strategic Assessment Branch, OMA/NOAA, Rockville, MD.